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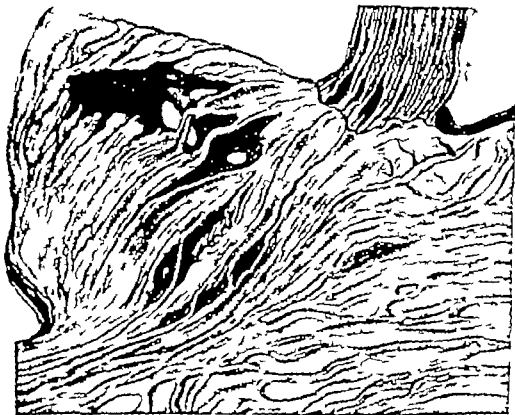
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Plat. Case. T show gross appearance of mucosal surface of stomach and lower esophagus. Note punctate hemorrhages, extensive hemorrhagic erosions, and three large perforations.

Peptic Ulcer and the Interbrain — Harvey Cushing

SURGERY, GYNECOLOGY AND OBSTETRICS

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NUMBER 1

PEPTIC ULCERS AND THE INTERBRAIN¹

HARVEY CUSHING, M D, BOSTON

Professor of Surgery Harvard University

THE generous founder of this lectureship, Dr Donald Balfour, has recently reported the results of one thousand and more surgical procedures on the stomach and duodenum as conducted during the year 1930 in the famous Clinic to which he is attached. Sixty-five per cent of the operations were for acute, subacute, or chronic, gastric, duodenal, or gastrojejunal ulcers. Since it is reasonable to assume that only a small proportion of the patients with peptic ulcers of one sort or another that sought advice during this period were operated upon,² these figures indicate that the condition represents one of the most common maladies of the present day.

Until roentgenology and the opaque meal came to add a measure of precision to our clinical diagnoses, many ulcers naturally enough went unrecognized during life, but it is highly unlikely that they should have been similarly overlooked by pathological anatomists by whom forty years ago duodenal ulcer, at least, was looked upon as a rare disorder. What my colleague, Dr Christian, has recently pointed out³—that the incidence of many maladies, commonly seen in his wards

during the past fifteen years, has remained stationary or fallen off whereas gastric and duodenal ulcer has increased four-fold—can scarcely be ascribed wholly to improved methods of diagnosis.

Since the characteristic local lesion may be the only discernible evidence of disease to be disclosed after death, it has naturally enough been ascribed to purely local causes—vascular, traumatic, bacterial, biochemical or secretory. By various ingenious experimental devices, many have succeeded in producing acute peptic ulcers or erosions in the lower animals, and under certain circumstances the mucosal defects thus produced fail to heal. But it is only in man that ulcers occur spontaneously with any considerable frequency, and it is not at all improbable that the prevalence, particularly of duodenal ulcers, has something to do with the strain and stress of modern life, for people today rarely find it possible to lead the comparatively placid existence enjoyed by their forebears.

All clinicians are familiar with the facts (1) that "highly strung" persons are particularly susceptible to "nervous indigestion" and associated ulcer, (2) that ulcers become symptomatically quiescent or even tend to heal when patients are put mentally and physically at rest, and (3) that symptoms are prone to recur so soon as the victim of the disorder resumes his former tasks and responsibilities. Though this emotional or psychic aspect of

¹In a later issue of the weekly *Proceedings of the Mayo Clinic* for October 7, 1931 Dr H. R. Hartman states that in 1930 the diagnosis of gastric or duodenal ulcer was made in 2,499 patients. In 2,015 instances (80 per cent), the lesion was duodenal, in 224 instances (10 per cent) gastric and in 57 cases (2 per cent) both gastric and duodenal ulcers were present. Of the duodenal ulcers 797 (of 39 per cent) and of the gastric ulcers 155 (69 per cent), were operated upon.

²Sixteenth Annual Report of the Peter Bent Brigham Hospital for the year 1929 p 139.

³Being the basis of the fourth Balfour Lecture, given a year ago at the University of Toronto April 8, 1931.

the ulcer problem has been frequently emphasized in the past, the locus of the primitive emotions and their relation to parasympathetic discharges and vagotonia has only come to be partly understood in recent years. It is proper therefore at the outset to disclaim any pretense toward a novel explanation of the pathogenesis of ulcer. At the same time the hope is expressed that what will be forthcoming may serve in a measure to reconcile the several conflicting hypotheses, many if not all of which doubtless contain certain elements of truth.

What has incited my interest in the subject has been the disturbing experience of having lost three patients from acute perforations of the upper alimentary canal soon after what appeared to be successful operations for the removal of intracranial tumors and that each of these tumors happened to be situated in the cerebellum could not it seemed to me be other than of some significance. How to explain these occurrences was the difficult problem and in the attempt herein to do so I may best proceed by first giving an account of the three distressing episodes.

I. CASE REPORTS

a. Acute Postoperative Perforations

These as stated in all three instances followed suboccipital operations for cerebellar tumors.

CASE I (P. B. B. II Surgeon No 3095.) Cerebellar symptoms of six months' duration. Suboccipital exploration under ether anesthesia. Evacuation of subarachnoid angioblastoma from right cerebellar hemisphere. Acute abdominal symptoms. Death in 24 hours from general peritonitis due to multiple perforations of the stomach.

June 11 1915. On the advice of Dr. C. C. Barney of Malden, Massachusetts, the patient Alvar C. aged 34 years, a bank clerk, was admitted to the Brigham Hospital because of a choked disc and other evidences of brain tumor.

Past history. He had had scarlet fever as a child complicated by an otitis media, also an attack of typhoid when aged 20 years, but otherwise had always enjoyed good health until the onset of his present symptoms. He had been married nine years, had raised a family and was a man of exemplary habits.

Anamnesis. In December 1914 six months before admission, he began having suboccipital headaches followed ere long by falling vision. In March 1915, his gait became unsteady and a month later he began to have attacks of morning vomiting accompanied by nausea. Diplopia, dizziness, and tremor of the hands had also been recently observed.

Physical examination. Apart from the neurological signs, which were unequivocally those of a right cerebellar tumor with secondary hydrocephalus and choked disc, the examination was wholly negative. Regarding the abdomen, the record states that "no masses were seen or felt no tenderness, muscle spasm or rigidity. Spleen and kidneys not palpable. Liver dullness extends to costal margin in mid-clavicular line. Percussion note everywhere tympanitic."

Operation. June 17 1915, 10 a.m. The patient was placed face-down in a comfortable position on the cerebellar table and anesthetized by warm ether vapor the Connell apparatus being used for its delivery through a nasal tube. The usual bilateral suboccipital exploration was made with exposure of both cerebellar hemispheres and removal of the bone comprising the posterior half of the foramen magnum. To lower tension the left lateral ventricle was punctured before opening the somewhat tense dura. On reflecting the membrane a superficially placed, evidently benign tumor was disclosed in the center of the right cerebellar field. The tumor about the size of a golf ball, was readily encapsulated intact owing to its smooth surface and definite capsule. The bleeding was trifling and easily controlled by a few clips. The wound was closed carefully in layers in the usual detail.

The anesthetic had been given by Dr. W. M. Boothby with the Connell apparatus and was smoothly taken. The operation lasted just short of three hours and at its conclusion the patient was in good condition and there seemed to be no reason to expect anything other than an uneventful recovery.

Subsequent notes. On first regaining consciousness (1:30 p.m.) while still in position on the operating table the patient complained of feeling chilly and of abdominal discomfort. He vomited more than usual (a bile-stained fluid) and his bowels moved freely the stool containing mucus streaked faintly with blood. After he was removed from the table at 3:30 p.m. he complained of increasing abdominal pain the belly seemed somewhat stiff and tender to palpation but no especial significance was attached to the fact. During the rest of the afternoon he continued occasionally toretch, vomit, belch and pass gas per rectum. He had also a peculiar grunting expiration which, however, was regular and without Cheyne Stokes rhythm.

He was finally taken to the ward at 6 p.m. His rectal temperature was then 101.4 degrees. Owing to restlessness and further complaints of abdominal pain, he was given at 8:30 p.m. sixth of a grain of morphia subcutaneously. Not long after this his pulse and respiration began to quicken and at 9:30

This case has been briefly reported in another connection. Condon and Bailey. Brain Tumor of the Brain. C. Thomas, 1916, Case XI, page 14.

p m to quiet him he was given another one-sixth of morphia. From this time onward he became progressively worse, at 1 00 a m his rectal temperature was 104 degrees. His appearance an hour later, when I was called to see him by my then assistant, Dr E B Towne, reminded me of a state of "hyperthermic shock," whatever was meant by that.

My personal notes state "2 a m He is conscious, alert and subjectively comfortable but breathing rapidly with an expiratory grunt, no rhythmicity about respiratory act, pulse very irregular, often barely perceptible and uncountable at the wrist. Extremities cold and clammy though he says they feel hot."

And again at "5 a m Has slept off and on the past three hours on his morphia. No change in general condition. Has voided. Difficult to tell what is wrong. He is mentally clear and cheerful. The abdomen is slightly distended and so sensitive it cannot be touched without making him wince. This superficial tenderness suggests some spinal cord (referred pain) complication. To exclude the possibility of a postoperative clot a lumbar puncture has been made. Fluid found clear and not under tension."

"6 30 a m Definitely failing though remains conscious and clear. Pulse barely perceptible. The condition now looks more like a general peritonitis as from a perforative ulcer, a mesenteric thrombosis, or acute obstruction (though no vomiting since morphia) than any intracranial condition with which I am familiar."

He grew increasingly worse, became cyanotic and nearly pulseless and the end came at 10 15 a m, just twenty-four hours after the start of the operation.

[It was subsequently learned from the patient's wife that on the day before his operation he had eaten some cake, brought to him by a visitor, and this had disagreed with him. Indeed, so long as she had known him, he had always had a poor digestion and would frequently regurgitate food "like a baby with an overfilled stomach." In 1903, he had had an attack supposed to be appendicitis with "stoppage" from which he had recovered without operation after discharging some dark material by the bowel.]

Postmortem examination (Dr J L Stoddard). The unrestricted autopsy was held at 1 15 p m., three hours after death. Apart from the recent operative wound the intracranial conditions were normal. There was no evidence of clot or postoperative oedema.

The peritoneal cavity contained a large amount of turbid fluid with a generalized acute fibrinous peritonitis particularly marked in the upper abdomen. The stomach showed three circular perfora-

tions half way between the cardia and pylorus on the lesser curvature (Fig 1, frontispiece). About these perforations there were no indurations or indications of inflammatory reaction. On opening the stomach an acute process was disclosed resembling the acute gastritis of a corrosive poisoning. There were widespread submucosal hæmorrhages and the mucous membrane in many places was so damaged the organ could readily have been torn by the fingers. The process was more marked in the cardiac half of the stomach and the lower portion of the oesophagus was likewise involved with longitudinal splits in the mucous membrane and submucosal hæmorrhages. In certain areas, as at the site of the three perforations, the wall was actually necrotic throughout.

Microscopical examination (Prof W T Councilman). *Stomach*. Sections from the involved areas showed a normal mucosa with no degeneration of the glands though in places there was a slight infiltration with polymorphous cells. Sections from the margins of the mucosal rents showed evidence of hæmorrhage into the coats as though torn by mechanical violence. The punctate areas in the fundus proved to be shallow, hæmorrhagic erosions (Fig 2) with marked oedema of the submucosa and a heavy infiltration of polymorphonuclear leucocytes involving all coats, even to the serosa, unmistakably an antemortem process.

In his further discussion of the case Dr Councilman expressed the belief that inflation of the stomach by ether vapor had produced the rents in the mucosa. This view was regarded, however, as highly improbable for the Connell apparatus, which gives a measured percentage in tension of warmed ether vapor, had been utilized without accident of the sort in thousands of cases, many of them patients with cerebellar tumors. Several other possible explanations were considered (1) for an acute corrosive poisoning there was no apparent source, (2) an agonal digestion of the stomach wall did not accord with the clinical evidences of peritonitis long before death, (3) the patient's face-down position for many hours on the operating table was considered as a possible cause only to be discarded.

At about this time, G M Smith [1] had shown that hæmorrhagic ulcerations or erosions with necrosis could be easily produced when a combination of bile and 5 per cent hydrochloric acid were experimentally injected into the fasting stomach of animals. There had been no occasion to make a gastric analysis of the patient before the operation, but the history subsequently elicited suggesting

that he had suffered from hyperacidity coupled with the fact that on recovery from the anesthetic he had vomited an abundance of bile stained fluid seemed therefore to offer the most plausible explanation of the lesions.

This harrowing experience unsatisfactorily accounted for was wellnigh forgotten when twelve years later it was vividly recalled by the series of events in the following case.

CASE 2 (Surgical No. 30113) *Cerebellar-tumor symptoms of five years duration. Suboccipital exploration under local anesthesia temporarily supplemented by ether. Incomplete electro-surgical extirpation of huge astrocytoma. Prolonged operation. Acute bilateral symptoms three days later with death on fourth post-operative day. Autopsy: multiple acute perforations of duodenum.*

George M., an engineer 34 years of age, was admitted November 16 1927 with the full blown picture of a cerebellar tumor. Symptoms had occurred with the following chronology. For five years, dizziness on stooping with subsequent blurring of sight, also suboccipital stiffness and tenderness for three years, occasional attacks of vomiting without nausea; for two years, increasing dysarthria and dysphagia, ascribed to the extraction of teeth for eighteen months, loss of visual acuity, for ten months, staggering gait for six months, increasing weakness of the right side for three months, occasional "cerebellar fits" with retraction of neck, sweating, dizziness, and temporary unconsciousness for two months, periodic diplopia.

Examination. This showed a bilateral choked disc of 5 diopters, marked ataxia and slight hyperesthesia of all extremities, sustained nystagmus to either side, left abducens palsy, marked static instability with tendency to deviate to the right, suboccipital tenderness, right astereognosis, dysphagia and dysarthria.

Operation. November 20, 1927. The cerebellum was exposed by the usual bilateral crossbow incision with puncture of the dilated lateral ventricles. A median tumor was disclosed which grossly resembled an ependymoma but which proved to be a fibillary astrocytoma. It had a long tongue projecting so far into the spinal canal that a laminectomy of the axis as well as of the atlas was necessary in order to expose its lower pole (Fig. 3). This forbidding growth was radically attacked but its extirpation was finally abandoned short of completion owing to respiratory difficulties set up by manipulations of the residual fragment which overlay the posterior floor of the ventricle.

The operation was started at 10.30 a.m. under novocain anesthesia at 12.30 p.m., because the handling of the tumor was causing the patient dis-

tress, inhalation narcotics was substituted. Owing to the tough, rubbery character of the growth it was removed piece meal by electro-surgical methods, and the current was frequently in use during the three hours from 12.30 to 3.50 p.m. while the patient was under ether. The wound closure was not completed till 5.30 p.m. by which time consciousness had been wholly regained.

Postoperative course. The patient was kept on the cerebellar table during the next several hours, for though his general condition was satisfactory, this position enabled the mucus and saliva, which he had difficulty in swallowing, to drain from his mouth. In two hours the rectal temperature had risen to 101.8 degrees. He was sponged and the temperature fell. At 11 p.m. he was removed from the table to bed. By 7.30 a.m. the next morning, he was thought to be out of danger and was returned to the ward, pulse 110, respirations 12, rectal temperature 101 degrees. He took liquid nourishment well though the pre-operative difficulty in deglutition was evidently increased. A lumbar puncture was performed, 35 cubic centimeters of blood tinged fluid not under tension being removed.

His condition appeared in every way to be satisfactory during the next two days until 4.15 p.m., December 2, when he had a sudden violent epigastric pain which spread over the abdomen and into the shoulders. This was ascribed to a probable pleuritis and an attendant thought he heard a friction rub in the right anterior axillary line. Rectal temperature was 102.4 degrees. He soon became exceedingly restless and was given 10 milligrams morphia, which quieted him. The temperature continued to rise during the night and at 5.30 a.m., December 3, had reached 102 degrees. There had been no vomiting and no suspicion of an acute abdominal complication was at any time aroused. The radial pulse became imperceptible and he died at 8.15 a.m. on this, the fourth postoperative day.

Postmortem examination 4 hours after death (Dr. G. A. Bennett). The brain showed a residual mass of non-adherent tumor deeply indenting and flattening the medulla (Fig. 4). The lungs apart from slight hypostatic congestion were normal in appearance.

The **peritoneal cavity** was found to contain 1100 cubic centimeters of a dark reddish-brown fluid. When this was removed a generalized diffuse fibrinoplastic peritonitis was disclosed. On separating the intestines which were held together by the sticky fibrinous exudate two perforations of irregular shape, through which the contents of the bowel were easily expressed, were found in the wall of the duodenum about 5 centimeters distal to the pylorus (Fig. 5). The larger opening measured roughly 12 by 14 millimeters, the smaller 9 by 8 millimeters. Neither of them was indurated or showed evidence of a chronic inflammatory process. About 5 centimeters farther down the duodenum were two shallow ulcerations or erosions in the mucous membrane, the larger of them measuring 8 by 4 millimeters in diameter. The



Fig 2 Case 1 Typical punctate hæmorrhagic erosion extending through submucosa (mag $\times 15$)

gastric mucosa, the ampulla of Vater, the pancreas, and its ducts were all of normal appearance

Microscopical examination Sections at the margins of the perforated areas showed merely a loss of structure with marked œdema and fibrin deposition. Those taken through the erosions showed a completely destroyed mucosa which was replaced by an exudate of fibrin inflammatory cells, and blood, the submucosa and to some extent the muscularis were œdematous and heavily infiltrated with polymorphonuclear leucocytes, lymphocytes, and fibroblasts. Homogeneous blue-staining thrombi, in which polymorphonuclear leucocytes were incorporated, were present in the capillaries, small arteries, and veins both of muscularis and submucosa. Occasional arteries of considerable size were surrounded by coarse meshed fibrin. These features, in the opinion of the pathologists, were those constantly seen in duodenal ulcer and indicated that vascular thrombosis was the local cause of the lesions which were unmistakably antemortem in origin.

The operation in this case, as events proved, was ill judged, for the patient might have recovered had the tumor been left alone and the chance taken of providing symptomatic relief by decompressive measures. But this source of regret lies apart from the present discussion. What concerns us is the fact that here again was a fatality from a perforative peritonitis, wholly unsuspected during life. The attack of acute abdominal pain, which doubtless ushered in the process, was wrongly ascribed

to a probable pulmonary complication brought about by the patient's deglutitory difficulties.

As in the first case, in an effort to explain the multiple perforations which here, to be sure, were duodenal rather than gastric, it was necessary again to consider (1) the man's face-down position on the table, (2) the prolonged operative procedure, (3) the three-hour period of ether anæsthesia with the Connell apparatus, and (4) the possibility of trauma in lifting the patient from the table. There moreover, was the additional element of the powerful electrosurgical current that had been used with the negative electrode against the abdomen, the possible complications from which, in 1927, were unknown to us. Time, however, has shown from a multitude of other experiences that diathermy does not damage the nervous tissues, and though we have once seen a superficial burn due to imperfect contact of the large negative electrode against the skin, no other ill effects have ever been observed.

Here, then, was another distressing experience following a cerebellar operation with an early postoperative fatality due to multiple duodenal perforations for which there was no ready explanation. The account of a third episode of similar kind follows.

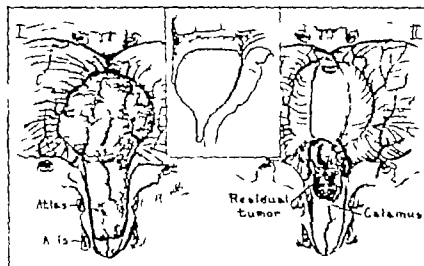


Fig. 3. Case 2. Showing: I Medial sacrocystoma with spinal process necratising laminae of both atlas and axis for its exposure II the residual part of the tumor

CASE 3 (Surgical No 30532) *Highly advanced cerebellar syndrome in a child. Suboccipital operation under ether with incomplete removal of large vascular medulloblastoma. Tra spulsion. Postoperative dysphagia with vomiting of brown fluid. Second reopening of craniophagus with digestion of mediastinal tissues.*

January 27 1928. On the recommendation of Dr John L. Eckel of Buffalo, Joseph C. 10 years of age, was admitted as an emergency with the unmistakable signs of a cerebellar tumor. The symptoms in their order of onset were as follows: For two or three years clonus, instability and ataxia for six months, increasing dysarthria for three months, suboccipital headaches and vomiting for one month, flaccidus and lateral spasm.

Examination showed a bedridden child with an enlarged head, a secondary optic atrophy with near blindness, a persistent wandering nystagmus, a left abductor palsy, paresis of left facial nerve, slurring of speech, marked ataxia, hypotonicity and hypermetria of all extremities with absent deep reflexes.

Operation. January 27th. 10:30 a.m. As the child was too ill and unco-operative for local anesthesia gas-ether was employed. The suboccipital approach was exceedingly difficult and bloody. In spite of a preliminary ventricular puncture so soon as the left cerebellar hemisphere was exposed a huge medial tumor began to extrude through the thin overlying cortex. The growth was so vascular it was mistaken for an angiomatous cavernoma. It was impossible to do more than to scoop and sock out what appeared to be the chief mass of the growth and to control bleeding by electrocautery methods and temporary packing. It was a desperate procedure and not until four hours had elapsed was it thought safe to close the

wound. The child's radial blood pressure during the last hour was too low to be registered but a transfusion of blood was given with prompt improvement. The extirpation was necessarily left incomplete but it was hoped that enough of the growth had been removed temporarily to relieve pressure symptoms while radiation therapy could be employed.

On the following day January 27 fear from the child's symptoms that a clot might have formed at 11 a.m. the entire wound was reopened under local anesthesia.

At this session great masses of highly infiltrated tumor which were extruding from the cavity were removed with further loss of blood necessitating a second transfusion which promptly restored the fallen pressures.

During the remainder of this second day and night, the child seemed much improved and there was hope of recovery. Apart from the occasional vomiting of brownish coffee ground fluid, which caused us to apprehend possible erosion of the gastric mucosa, conditions seemed favorable until 6 a.m. on January 28 when there was a sudden rise of temperature to 104.4 degrees. This was associated with labored respiration, bronchial rales and considerable cyanosis. Two hours later the temperature had risen to 106 degrees. There was copious vomiting of brownish black fluid.

On the remote chance that the only orifice was due to a clot or to a further dislodgment of infiltrated tumor the wound 10 c.m. was again quickly opened and closed without an thing being found to account for the symptoms. A third transfusion was given with imagined improvement but this was temporary and the child died at 1:4 p.m. with a temperature of 106 degrees, some 50 hours after the first operation.

Autopsy one hour after death unrestrictd (Dr R. Z. Schull). The brain showed a large residual mass of the tumor which extended up into the lateral recess alongside the brain stem and projected through the foramen tentorii flattening the side of the pons (Figs. 6 and 7). There was a secondary hydrocephalus of high degree. The tumor proved to be a medulloblastoma.

In the further progress of the examination the peritoneal cavity and the subdiaphragmatic organs

were found to be normal in all respects, this was true also of the right chest. The left pleural cavity, however, was largely filled by dark brownish fluid of precisely the same type that the patient had occasionally vomited, floating on its surface was a considerable amount of free fatty material and whitish debris. When, after removal of the fluid, the normal-appearing and crepitant lung was tilted forward, it could be seen that the pleura, over a large area including the side of the pericardium, the dome of the diaphragm, the bodies of the vertebrae and posterior thoracic wall, had been digested away together with the fat and areolar tissue of the mediastinal space. This left the aorta and its branches, the mediastinal nerves, the vertebrae, and the oesophagus cleanly exposed as in a dissection (Fig. 8). In the side of the oesophagus was a ragged hole about 3 centimeters in length from which, on compressing the stomach, the same brownish material found in the chest could be expelled.

Specimens of the free fluid after filtration showed a total acidity percentage of 52, which is about the upper limit of normal for free and combined acids in gastric contents. A piece of omental fat *circa* 5 centimeters in diameter was incubated in 40 cubic centimeters of the fluid and in 48 hours had disappeared, many fat globules remaining on the surface. A piece of muscle similarly treated was reduced to about a fifth of its original size in 72 hours.

Microscopical examination of the lower oesophageal wall showed a highly oedematous and partly autolyzed tissue containing occasional erythrocytes and an abundance of polymorphonuclear leucocytes.

Here, as in the two preceding cases, there were definite antemortem evidences of the lesion. The dark colored vomitus suggested an erosion somewhere in the upper alimentary canal, but the absence of all abdominal signs threw us wholly off the track, an oesophageal perforation being unsuspected.

This startling experience was reminiscent of that in the two foregoing cases only for the reason that the antecedent operations had

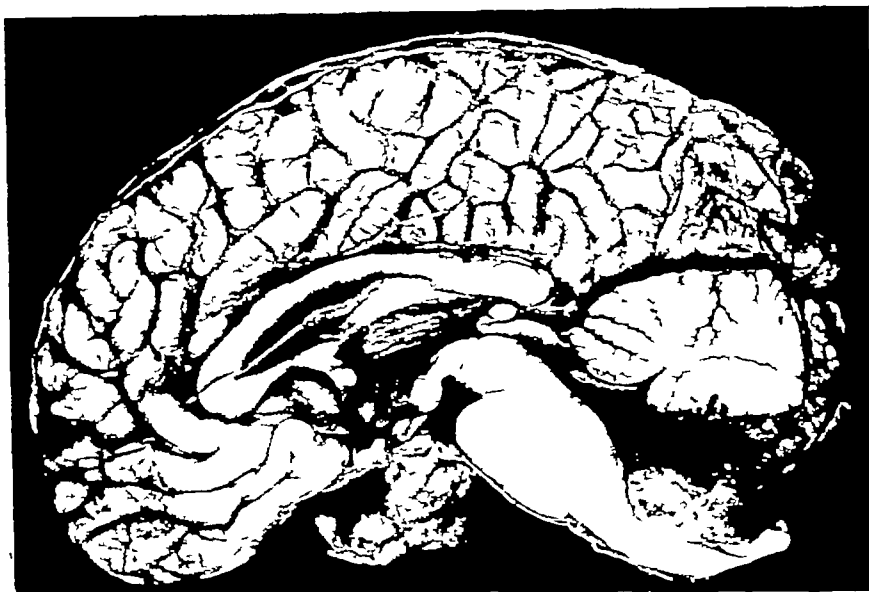


Fig. 4 Case 2 Showing flattening and indentation of the medulla by residual fragment of the non-adherent tumor

also been for a cerebellar tumor. Otherwise, there might have been no inclination to seek a common explanation for the three episodes, particularly since the perforative lesion occurred in a different situation in each instance. This child at the time of operation was in a seriously enfeebled condition and in view of the subsequent hyperthermia might well enough have had an agonal digestion of the oesophagus, and this was the contemporary belief expressed by the pathologists. Oesophageal perforations of like kind I recall having occasionally seen years ago at autopsies on typhoid-fever victims, it having been assumed that the perforation was due to regurgitation of gastric contents into the oesophagus, and to non-perforative ulcers of this same origin the once not uncommon post-typhoidal strictures of the oesophagus were formerly ascribed. It is, of course, known that true peptic ulcers may occur in aberrant islands of gastric mucosa [2] in the lower oesophagus just as they may occur in the patches of gastric mucosa in the presence of Meckel's diverticula [3], but these anomalously situated lesions, though they may have some bearing on the subject, lie apart from the present discussion.



Fig. 5. Case 2. Showing (slightly reduced) the perforations and erosions of the duodenum.

In each of these three cases, furthermore there were antemortem symptoms shown in Case 1 by acute abdominal pain, tenderness, and distention which preceded death by twenty hours in Case 2 by sudden acute upper abdominal pain sixteen hours antecedent to death and in Case 3 by the vomiting of fluid discolored by changed blood and by respiratory disturbances for some twelve to fourteen hours before death. The operations in Cases 2 and 3 were highly critical procedures that must seriously have drawn upon the patient's resistance but this was not true of the operation in Case 1. From these three observations, it is altogether natural to assume that erosions which may not go on to actual perforation, are possibly of more frequent occurrence after operations for brain tumor than is commonly supposed. To this question we may now turn.

b Antemortem Mucosal Erosions

Mucosal erosions whether they happen to be hemorrhagic in type or conform to the so-called stigmata of Bencke [4] are well known to pathologists. They were fully described by Carl Rokitsansky and Samuel Wilks in his celebrated *Lectures on Pathological Anatomy* stated [5]

"We occasionally meet with small gastric ulcers, perhaps entirely unsuspected in the fatal illness, the symptoms having been overwhelmed by those of the main disease. These we have seen as single, reniform, or circular erosions, generally near the pylorus, sometimes they are quite shallow and a little blood extravasated in the mucous membrane around would give rise to the suspicion that hemorrhage into the tissue, weakening it and leading to its solution, may be a cause of such ulcers.

The circumstances that permit one to demonstrate mucosal erosions after an intracranial operation are not often combined namely (1) an operation of the sort to produce them (2) a postoperative fatality at the proper time to find them, for the multiple small erosions such as may be produced by a great variety of experimental methods are known to heal over quickly (3) permission after a fatal operation on the brain for an unrestricted autopsy and (4) a more careful scrutiny of the gastroduodenal mucosa than is customary particularly when the obvious cause of death lies elsewhere.

The absence of one or another of the four necessary factors mentioned may in part explain how it is that only two examples are here recorded. One of them happened to be come upon while making a statistical study of the cerebellar astrocytomas a few years ago.

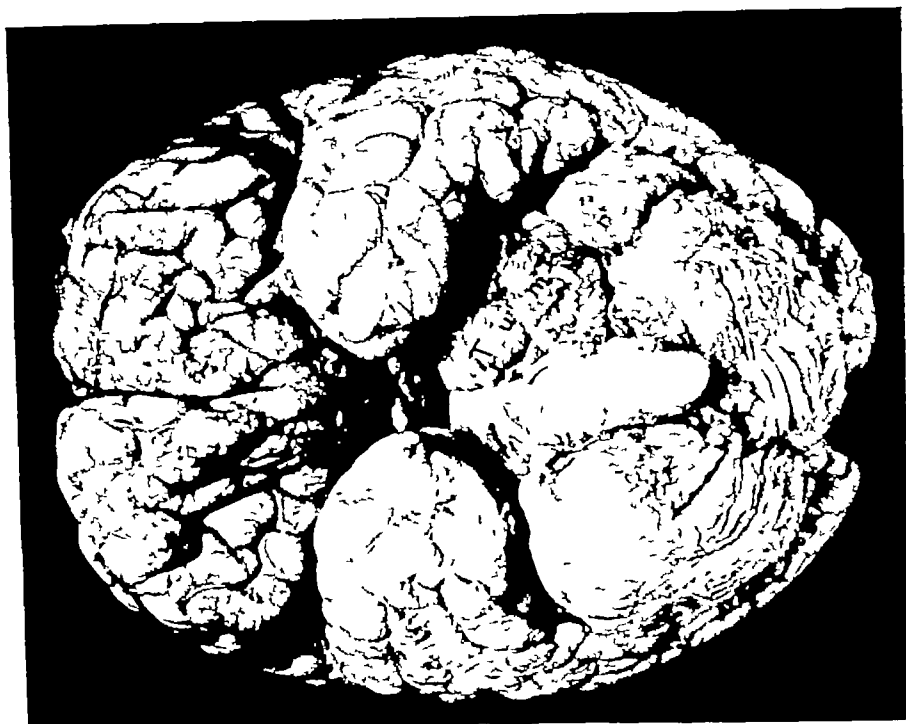


Fig 6 Case 3 Showing residual tumor mass (medulloblastoma) extending into left lateral recess

CASE 4 (Surgical No 664) *Recurrent cerebellar astrocytoma* Death after third operation due to streptococcal meningitis Hemorrhagic erosions of stomach noted at autopsy

A child, six years of age, with an advanced cerebellar syndrome and blindness first came under observation at the Johns Hopkins Hospital, and on May 24, 1910, a large cerebellar cyst was opened and drained with freedom of symptoms for a year. On August 3, 1911, a large, recurrent, cystic tumor was partially removed by the late Dr E H Nichols of Boston, again with a good temporary recovery. On December 8, 1913, she was admitted to the Brigham Hospital for recurrence of symptoms, among which occipital headaches, projectile vomiting, and constipation were prominent. At a third operation, a solid tumor mass was removed, the child dying six days later from a streptococcal meningitis with a temperature of 107 degrees.

The protocol of the autopsy, held 3½ hours after death, states that "Near the cardia along the greater curvature are found several areas where the mucous membrane is lacking, the largest measuring 3 millimeters in diameter. The bases of these ulcers (*sic*) are reddened as is also the fundus of the stomach."

No sections were cut and the lesions were simply recorded by painstaking observers as incidental findings.

How often similar small erosions of the gastric mucosa may occur after cranial operations is wholly conjectural but their presence would explain why the vomitus not infrequently contains traces of blood which ordinarily is supposed to have been swallowed. The following is a recent example of erosions found at autopsy after a fatal operation for a lesion in the subfrontal rather than the cerebellar region.

CASE 5 (Surgical No 37259) *Extirpation of large olfactory groove meningioma* Injury to anterior cerebral arteries and fatality after 48 hours Hemorrhagic erosions of stomach found post mortem

A 53 year old mill worker entered the hospital September 11, 1930, on the recommendation of Dr I A Farrell of Pawtucket, Rhode Island. For six months he had been working under a strain and his family learned accidentally that he had been vomiting every morning while at work and that he had shown some emotional instability. He was supposed to have a nervous breakdown. Three months later he began to have impairment of sight in the right eye with increasing weakness in the left side of the body.

Examination This revealed an apathetic, hemiparetic man with impaired memory and some disorientation. There was an apparent left homonymous



Fig. 7 Case 3. To show (nat. size) involvement of brain stem by residual tumor.

hemianopsia to rough tests, a low grade of choked disc and loss of sense of smell in the right nostril. A diagnosis was made of a right frontal tumor possibly an olfactory groove meningioma; this diagnosis was supported by ventriculography.

Operation. On September 23, under novocain anesthesia, a large right frontal bone flap was turned down disclosing a tense dura. After reflecting this membrane and uncapping the right frontal lobe a typical nodular meningioma of considerable size (132 grams) was disclosed. The temptation to enucleate this tumor intact rather than by preliminary excitation and piecemeal removal was not resisted. At the final moment of dislodging the solid growth (Fig. 9) from its bed, there was a sudden profuse hemorrhage. Both anterior cerebral arteries firmly embedded in the tumor had been torn off. They were fortunately caught up in the sucker and occluded by clips before there was a serious loss of blood.

Following this operative accident the patient as was anticipated, had bilateral spastic paralysis of both lower extremities associated with spontaneous clonic movements. He exhibited the usual clucking and grasping reflexes in the right hand which alone retained spontaneous movements.

On the following day when the wound was dressed some slightly blood tinged cerebrospinal fluid was removed from under the flap. Because he was taking nourishment poorly a nasal tube was introduced which withdrew about 50 cubic centimeters of coffee-ground material in which erythrocytes were demonstrable by microscopical examination. On the second day his temperature suddenly rose to 107 degrees and he died in hyperthermia 48 hours after the conclusion of the operation. Shortly before his exitus he vomited a large amount of bloody fluid.

Autopsy. Permission was given for an unrestricted and immediate examination which was made twenty minutes after death (Dr. R. Z. Schulz). It was found that the tumor had been cleanly removed except for a small fragment incorporated with the stump of the right internal carotid artery. A clip had been placed apparently on the middle cerebral artery on the right side probably also on the anterior cerebral on the left though this could not be precisely determined.

On opening the stomach numerous flecks of coffee ground material suggesting changed blood were found, also spots of recent hemorrhage with small clots attached to the surface of the mucosa which was studded with numerous small punctate ulcerations varying from 1 to 3 millimeters in diameter. When looked at through a magnifying glass (Fig. 10) they proved to have slightly irregular margins. The erosions were very superficial and were found scattered everywhere both in fundic and pyloric regions, with no site of predilection. The mucous membrane of the esophagus and small intestine was normal in appearance.

Microscopical examination. Sections of the stomach showed numerous small mucosal hemorrhages, some with overlying erosions and some with the mucosal surface still intact (Fig. 11). They were looked upon as essentially recent antemortem capillary hemorrhages. The red blood cells were well preserved and there was neither deposition nor phagocytosis of blood pigment. There was no evidence of arterial or capillary disease or any noteworthy constriction or thrombosis of the vessels. Nowhere were hemorrhages observed in the submucosa, the architecture of which was normal in all respects.

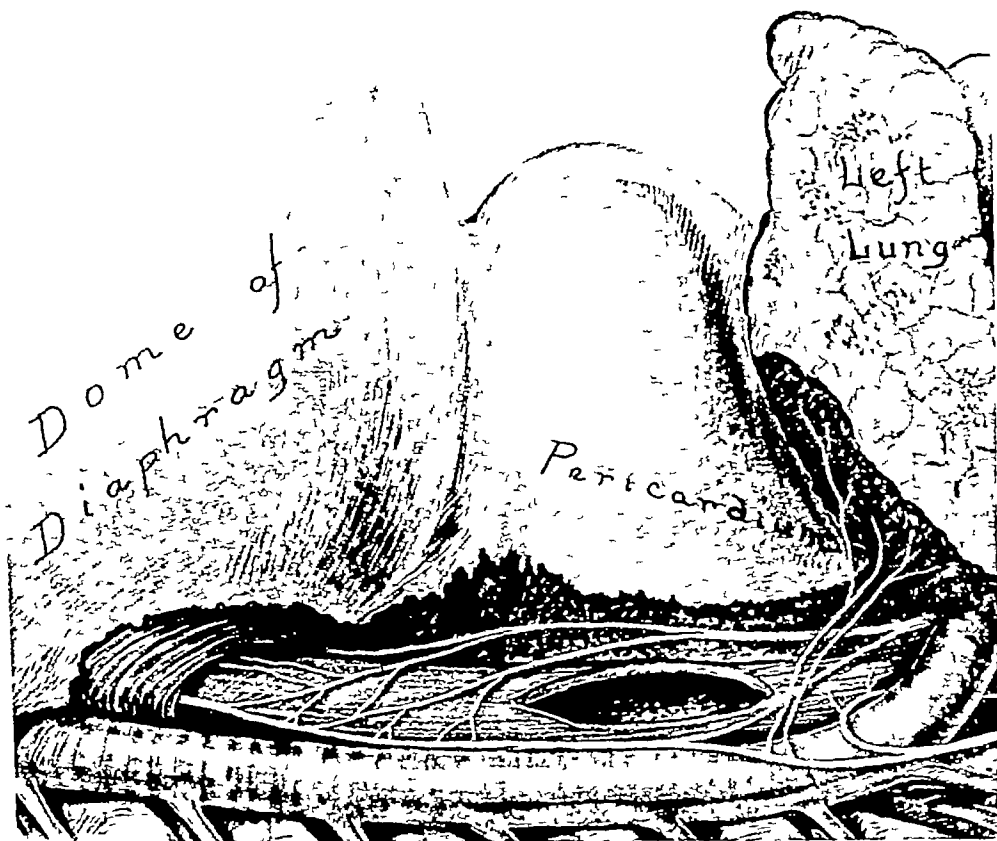


Fig 8 Case 3 Showing position of œsophageal perforation and upper visceral margin of mediastinal digestion leaving nerves and vessels wholly naked

Had we not been on the alert by this time (1930) for mucosal erosions after fatal operations for brain tumor wherever situated, it is safe to say that the minute lesions described might easily have escaped notice or have been regarded as of no significance. Their histological appearance coupled with the finding of demonstrable blood in the gastric contents twenty-four hours before death clearly indicates their antemortem character. Attention may be called to the fact that an olfactory groove tumor of the type described underlies the frontal lobe, and its posterior projection, overriding the optic chiasm, necessarily deforms the third ventricle. There consequently is always a risk of injuring important structures in the final dislodgment of the posterior fragments of such a growth even when it is removed piece-meal, and either from trauma

or because of the vascular accident described in the operative note, the operation in this case was equivalent to a decortication of the frontal lobes. While the relation to the subject in hand of this particular fronto-diencephalic region will be fully considered later on, it may suffice at the moment to point out that the seat of the operative manipulations was far removed from that associated with the perforative lesions and erosions mentioned in the four preceding case reports.

c Gastric Erosions and Perforation Accompanying Malignant Hypertension

Lesions similar to those already described occur in patients with intracranial conditions other than actual tumor. Two recent examples of malignant hypertension associated with choked disc may be briefly cited in



Fig. 7. Case 3. Tumor (nat. size) involvement of brain stem by residual tumor.

hemianopsia to rough tests, a low grade of choked disc and loss of sense of smell in the right nostril. A diagnosis was made of a right frontal tumor possibly an olfactory groove meningioma; this diagnosis was supported by ventriculography.

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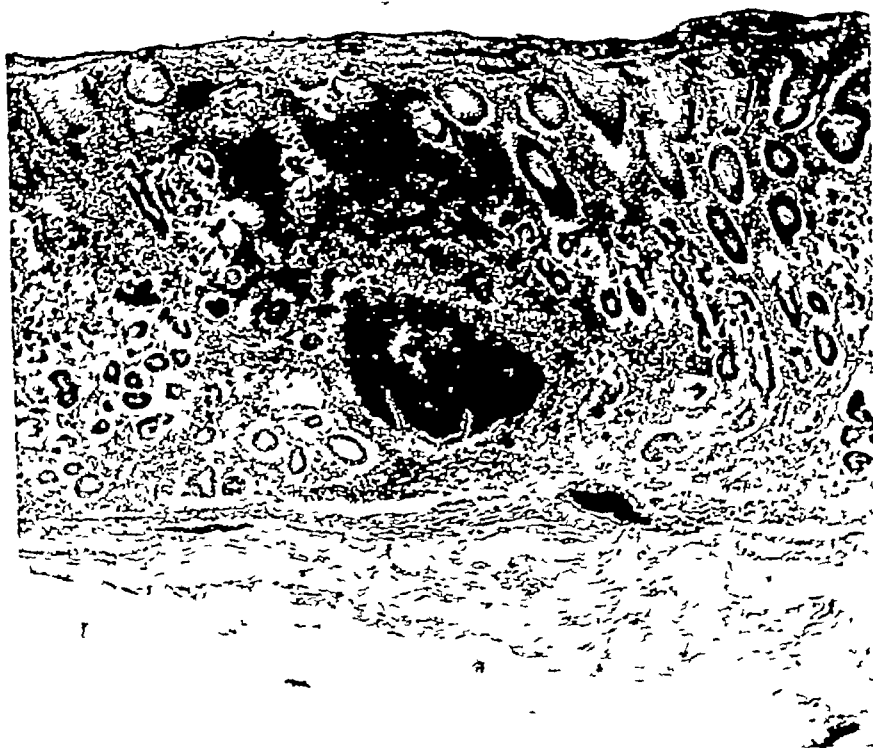


Fig 11 Case 5 Type of antemortem mucosal hæmorrhage associated in other areas with erosions (mag $\times 75$)

and the heart was slightly enlarged. Occasional hyaline casts were found in the urine and on two occasions the slightest possible trace of albumin. The examination was otherwise negative.

On February 5, to exclude tumor, ventriculograms were made and the ventricular cavities found to be normal in position and outline. On February 10, a sudden hæmatemesis occurred with vomiting of 500 cubic centimeters of blood. This was repeated on the following day with the loss of another 800 cubic centimeters of blood. For the resultant secondary anemia (hæmoglobin 50 per cent, erythrocytes 1,920,000), the patient was treated medically and seemed to be doing well when suddenly at 5 p.m. on February 17 he was seized with severe epigastric pain, and an exploratory operation by Dr John Powers disclosed a perforation in the posterior wall of the stomach 1 centimeter in diameter and 8 centimeters proximal to the pylorus. This ulcer was closed, inverted, and plicated, and the patient transfused. He did reasonably well for the next five days when he became comatose and died February 22 at 7:30 p.m. with a rectal temperature of 104 degrees.

Autopsy (February 23rd, 8:15 a.m.) revealed a peritonitis restricted to the lesser peritoneal cavity with terminal septicæmia from a gas-producing bacillus. The sutures closing the perforation had been dissolved

away and the stomach was in shreds from auto-digestion. The pancreas had become involved and there was extensive fat necrosis. Postmortem changes in the brain, which was riddled with gas bubbles made its microscopical study unprofitable. Apart from considerable sclerosis of the cerebral vessels, there was no tumor or other observable organic lesion.

In striking contrast were the simple gastric erosions observed at the early autopsy on Case 6 and the extreme autolysis of the stomach found in this last case in which the examination had been delayed for twelve hours. The lesions in both might well enough have been regarded as having been due to post-mortem digestion had it not been for the hæmorrhagic nature of the erosions in the first case and the history in the other, of a perforation which occurred five days before death.

The possible dependence of what is known as gastromalacia upon some neurosecretory disturbance in the gastric wall prior to death may next be considered.



Fig. 9. Case 5. Lateral view of the olfactory groove tumor (mat. star) showing below the node that projected into the pituitary fossa between the anterior legs of the chiasm, also a branch of the torn anterior cerebral artery with clip.

illustration. In one of them the erosion led rapidly to perforation resembling the conical punched ulcer which in my student days was associated in the mind of the profession with some constitutional predisposition, more particularly with that once common disorder chlorosis.

CASE 6 (Medical No. 37972) *Malignant hypertension with choked discs. Moderate arteriosclerosis with cardiac hypertrophy. Hydrothorax. Death with hyperthermia. Autopsy: multiple recent gastric ulcers.*

On November 15, 1930 a poorly nourished, high strung divorcee 35 years of age, supporting herself and her children as a bookkeeper entered the hospital with a history of five months of headache, dyspnea, palpitation, insomnia, nycturia and indigestion, with occasional attacks of nausea and vomiting. Examination showed an enlarged heart, moderate arteriosclerosis, choked discs, a blood pressure of 270/150, and slight traces of albumin in the urine.

She developed hydrothorax, which was relieved by punctures, and in course of the next six weeks went gradually down hill in spite of all efforts to alleviate her condition. On January 7, she became unconscious, developed fever, remained in coma for 24 hours and after a series of convulsive seizures died at 1 a.m. on January 8 with a terminal temperature of 104 degrees.

Autopsy: 2½ hours after death (Dr. Hertig). The examination revealed chronic myocarditis, mild vascular nephritis, moderate general arteriosclerosis, bilateral hydrothorax, and multiple recent gastric ulcers. The gastric mucosa was found to be intensely

injected and to contain numerous, small stellate-shaped recent ulcerations, more marked on the lesser curvature, to many of which fairly recent blood clots were adherent. The mucosa of the duodenum was injected but without ulcerations. The gastro-intestinal tract elsewhere presented nothing of note.

Microscopical sections of the stomach showed, in addition to the recent acute erosions, a generalized congestion with thickening of the arterioles of the mucosa (Fig. 12). The base of the ulcerative defects contained a slight amount of necrotic debris, a few polymorphonuclear leucocytes, the surrounding stroma being infiltrated by leucocytes, plasma cells, and lymphocytes. The mucosa was greatly congested and many small, tightly contracted and thrombosed arteries were present both in mucosa and submucosa (Fig. 13). The larger vessels showed practically no intimal change.

In the following case—an example of the same clinical disorder—there had been an antemortem perforation of the stomach into the lesser peritoneal cavity.

CASE 7 (Surgical No. 35716.) *Malignant hypertension with choked discs. Moderate arteriosclerosis with cardiac hypertrophy. Hematemesis. Perforation of gastric ulcer. Operation. Death after five days. Delayed autopsy. Autolysis of stomach.*

On January 29, 1930 Seth W., a somewhat obese man, aged 44 years, was transferred from the Deaconess Hospital as a brain-tumor suspect because of headaches and falling vision associated with vascular hypertension of a year's duration. He was not a nervous person and had never been troubled by gastric symptoms of any kind.

Examination: This disclosed choked discs of six diopters with secondary trophic and visual acuity reduced to 20/200. The blood pressure was 160/145.



Fig. 10. Case 7. Showing (mag. X 20) the appearance of one of the punctate hemorrhagic erosions.

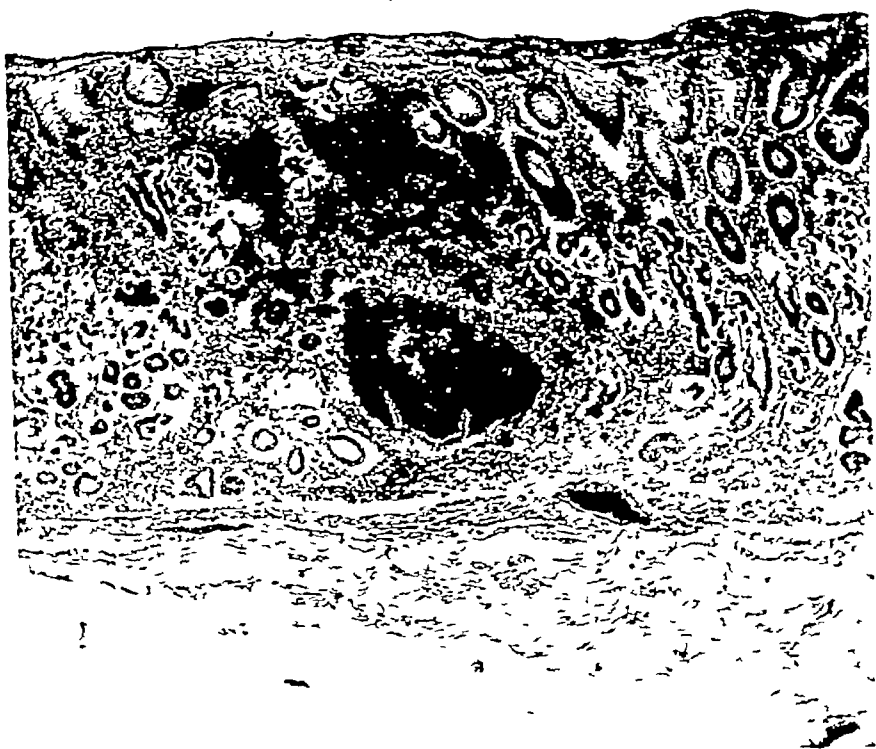


Fig 11 Case 5 Type of antemortem mucosal hæmorrhage associated in other areas with erosions (mag $\times 75$)

and the heart was slightly enlarged. Occasional hyaline casts were found in the urine and on two occasions the slightest possible trace of albumin. The examination was otherwise negative.

On February 5, to exclude tumor, ventriculograms were made and the ventricular cavities found to be normal in position and outline. On February 10, a sudden hæmatemesis occurred with vomiting of 500 cubic centimeters of blood. This was repeated on the following day with the loss of another 800 cubic centimeters of blood. For the resultant secondary anæmia (hæmoglobin 50 per cent, erythrocytes 1,920,000), the patient was treated medicinally and seemed to be doing well when suddenly at 5 p.m. on February 17 he was seized with severe epigastric pain, and an exploratory operation by Dr John Powers disclosed a perforation in the posterior wall of the stomach 1 centimeter in diameter and 8 centimeters proximal to the pylorus. This ulcer was closed, inverted, and plicated, and the patient transfused. He did reasonably well for the next five days when he became comatose and died February 22 at 7:30 p.m. with a rectal temperature of 104 degrees.

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away and the stomach was in shreds from autodigestion. The pancreas had become involved and there was extensive fat necrosis. Postmortem changes in the brain, which was riddled with gas bubbles, made its microscopical study unprofitable. Apart from considerable sclerosis of the cerebral vessels, there was no tumor or other observable organic lesion.

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The possible dependence of what is known as gastromalacia upon some neurosecretory disturbance in the gastric wall prior to death may next be considered.



Fig. 2. Case 6. Showing type of erosion associated with thrombosed vessels in submucosa (mag. $\times 22$)

d. *Gastromalacia*

In his first communication to the Royal Society made somewhat reluctantly at Sir John Pringle's solicitation, John Hunter stated that after death, a dissolution of the stomach at its great extremity is occasionally found and as this condition had been most frequently seen in the bodies of those who had died violent deaths, it was naturally ascribed to a postmortem continuance of digestion.¹ Why the stomach does not digest itself during life Hunter answered much as the question might be answered today by saying it can only do so when deprived of the "living principle." Even this was doubted by Claude Bernard and his English pupil Pavy of Guy's Hospital who showed that the solvent power of the gastric secretion could act on living tissue. It was assumed that the layer of mucus was what protected the secreting membrane from the action of its own juices, until Pavy in 1868 offered

an explanation so simple it met with almost universal approval at the time and in various guises is periodically revived—in effect, that the normally alkaline blood circulating in the stomach walls counteracts the acid of the mucosal secretion.

Death does not commonly occur among hospital patients with chronic maladies while their stomachs are digesting food and this may account for the fact that

what is known as gastromalacia, once the subject of ardent discussion, is nowadays infrequently seen and rarely mentioned. While something more will be said of this matter later on two examples of the process may here be cited as an extreme contrast to the minute erosions described in Cases 4, 5 and 6 and the acute perforative lesions in the first three cases recorded.

CASE 8. (Surgical N 2556) *Symptoms suggest a right cerebellopontine tumor. Negative exploration. Fatality on third day. Autopsy: Large aneurism of basilar artery. extreme atrophic gastromalacia.*

Archibald McL., a mining engineer aged 47 years, referred from the Battle Creek Sanitarium, was admitted January 11 1926 for a presumptive cerebellar tumor.

Anamnesis. There had been () for seven years, suboccipital headaches produced by any sudden jar and progressively increasing in severity () for four years, a continuous bilateral tinnitus deglory difficulties, a sensation of tightness () the right face and diplopia on looking to the left () for one year taxis of hands and a drunken stability of gait () for two or three months right facial palsy constipation and difficulty of emptying the bladder.

Examination. This disclosed low grade papilledema, nystagmus, a right trigeminal hypesthesia, paresis of the right face, a moderate bilateral deafness, ataxia of cerebellar type and an absent gag reflex.

¹ Years later, another Scot, Robert Cruikshank (cf. *Edinburgh Med. & S. J.* 1829, 1830, 1831-32), put forward this as the best of explanations advanced, "that the dependent portions of the stomach of rabbits killed after feeding, and always found dependent, () that the gastric juices being such an unusual transformer to the empty stomach of a dead animal would digest its wall; and (2) that autolysis did not occur in the stomach of an animal killed while starving, or in one whose gastric contents were immediately washed out after death. In short, postmortem putrefaction only occurs when the stomach is secreting." (It is assumed for Pavy and others in making clear that the presence of food in the stomach was not the only factor in exciting the flow of gastric juice.)

with some dysphagia and dysarthria. The blood Wassermann was negative, the blood pressure 140/80. A tumor of the right lateral recess was predicted.

Operation January 26 A suboccipital exploration under local anæsthesia failed to reveal the expected tumor. The manipulations, while in search of it, produced a marked fall in blood pressure and provoked spells of vomiting which continued off and on during the remainder of the procedure. There was no herniation of the cerebellar tonsils, in fact the upper spinal cord appeared to "ride" higher in the foramen than usual, the ninth, tenth, and eleventh nerves being well exposed to view. The wound was closed.

During the remainder of the day he vomited frequently and for some unaccountable reason his dysphagia and dysarthria were more marked than before. On the following day, *January 27*, though still nauseated his condition was good and no anxiety was felt regarding his recovery. On the morning of *January 29*, the third day, he seemed to be doing well but he was found at noon to have a temperature of 104 degrees. A lumbar puncture was performed disclosing faintly blood tinged fluid under no increase of tension. During the afternoon, the lungs began to fill with secretion, he became increasingly cyanotic, and passed into a deep stupor followed by death at 1:30 a.m. on *January 30*, the morning of the fourth day. Because of deglutitory impairment no nourishment had been taken by mouth for over 12 hours.

Autopsy 7:30 a.m., six hours after death (Dr H. Pinkerton). This disclosed (1) a large aneurism of the basilar artery greatly distorting the brain stem (Fig. 14), (2) generalized arteriosclerosis, (3) a terminal bronchopneumonia, and (4) gastromalacia. The peritoneal cavity in the region of the spleen contained 500 cubic centimeters of brownish dirty fluid containing small masses of mucus. The fundus of the stomach and lower œsophagus were found to be completely disrupted and in shreds. A perforation measuring 15 centimeters in diameter was present with dissolution of the adjacent stomach wall. The rupture extended up to the cardia and into the

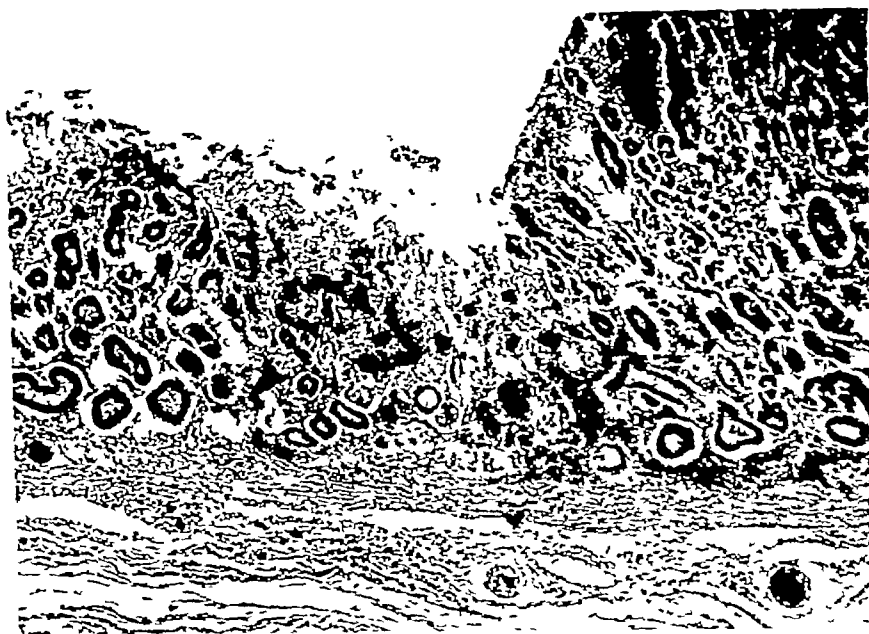


Fig. 13. Case 6. Showing congestion and thrombosis of mucosal veins with beginning erosion. Note constricted and thrombosed artery in lower right hand corner of field (mag. $\times 80$).

œsophagus for a distance of about 10 centimeters. The pyloric region showed considerable autodigestion which involved the superficial layers only.

Here was a typical example of postmortem autolysis of the stomach and œsophagus in which the presence of changed blood in the gastric contents was not observed during life. But inasmuch as no nourishment had been taken, the presence of half a litre of brownish fluid found free in the abdomen can scarcely be accounted for unless the gastric mucosa had been actively secreting long before the cessation of circulation.

In the following example of gastromalacia evidences that erosions were present before death are somewhat more definite.

CASE 9 (Surgical No 34711) Extirpation of right parietal metastatic hypernephroma. Death after 36 hours. Antemortem regurgitation of blood containing fluid. Autopsy: gastromalacia and œsophageal perforations.

John G., a carpenter, 58 years of age, was admitted *August 28, 1929*, in a stuporous condition with the history of headaches for the preceding six months. The eyegrounds were normal, there was no evidence of nephritis or arteriosclerosis. In the process of making a ventriculogram for diagnostic



Fig. 14 Case 8. Aneurysm of the basilar artery (not seen) mistaken for tumor of right lateral recess (cf. projection of sac to left) and causing marked deformation of brain stem.

purpose the needle entered a xanthochromic cyst in the right parietal lobe.

On September 10th (9 a.m.) an exploratory operation under novocain was made by Dr. Horrax and a partly cystic tumor which proved to be a metastatic hypernephroma was enucleated. On the following day at 10.30 a.m. because of continued stupor and a rising temperature (104 degrees) the flap was re-elevated under the mistaken belief that a post-operative clot had formed.

The patient remained unconscious and unresponsive with stertorous respirations and an evident hemiplegia. At 6.30 p.m. he was given a nasal feeding which was promptly regurgitated with a large amount of dark brownish material evidently containing changed blood. Death occurred at 9.45 p.m., eleven hours after the second operation with a rectal temperature of 37.4 degrees.

Autopsy: 3 hours after death (Dr. Connor). The brain showed edema of the right cerebral hemisphere but contained no additional metastases. There was a primary hypernephroma of the left kidney and bronchopneumonia. A bilateral perforation of the esophageal wall communicated with the right and left pleural cavities, each of which contained about 400 cubic centimeters of brownish mucoid fluid containing fat droplets. The esophageal openings measured from 4 to 5 centimeters in length and the adjacent esophageal tube was necrotic, only a few strands of fibrous tissue, nerves, and blood vessels remaining. The margin of the digested area in the thorax showed a border of reddening suggesting that the circulation must have been in action at least in the early stages of the process. The fundus of the stomach was highly necrotic, with only a few blood vessels, nerves, and strings of reddish mucous material

remaining. The pyloric end of the stomach was comparatively unaffected and the remainder of the gastro intestinal tract showed no change.

The important features of this example of oesophago-gastromalacia from the point of view of the present discussion are (1) the presence of dark-brown fluid (probably blood-containing) regurgitated three hours before death, (2) the note in the pathologist's protocol that the appearance suggested an antemortem even if an agonal process. As in Case 3, also with oesophageal perforation, it is difficult to understand how the pleural cavity should have contained such a large amount of blood-containing gastric fluid had the stomach not been actively secreting and have retained its motility after the perforations occurred even were they agonal events. As this is the only tenable explanation for the conditions found, it presupposes some disturbance of control on the part of the vegetative nervous system which served in some way to set aside Hunter's "living principle" and at the same time to provide an abundant gastric secretion. For in the absence of active gastric juice the process could hardly have occurred.

e Chronic Ulcer

All the lesions discussed up to this point might well enough have been ascribed to postmortem or agonal changes had it not been for symptomatic evidences of peritonitis or of pain or of blood in the gastric contents several hours before death. Even so, the process in all instances has been an acute one whereas the cardinal clinical feature of a gastric ulcer is its peculiar chronicity. This, first clearly pointed out by Cruveilhier, must have been known to John Hunter, to judge from Clift's drawings of some of his specimens published in Matthew Baillie's *Morbid Anatomy* (1799), but just what Hunter thought about them, unfortunately, went up in smoke when his manuscripts were burned.

What it is that favors chronicity in a gastric or duodenal ulcer is a much debated subject. All will agree, however, that an erosion of the mucosa must be the primary stage in its formation, and since there is every reason to believe that acute erosions (of the type described in Case 5) are of common occurrence, any one

of them may well enough be the precursor of a chronic lesion, should the original insult be sufficiently great or should a minor insult be continuous or frequently repeated at the same spot. As a matter of fact, a duodenal ulcer at least shows every inclination to heal, as indicated by the frequency with which shallow scars are found after death, and its tendency to recur, rather than any pathological evidence of chronicity, is its peculiar characteristic.

Only one pathologically verified chronic ulcer which, with reasonable assurance, can be ascribed to an encephalic lesion, has been observed in our tumor series. The history of the case follows.

CASE 10 (Surgical No 29708) Radical removal from a child of a median cerebellar medulloblastoma with wide opening of fourth ventricle. Repeated subsequent radiotherapeutic sessions. Death after two years. Massive intraventricular recurrence. Duodenal ulcer with evidences of cicatrization.

The patient, Ruth F.,¹ aged 9, was admitted September 23, 1927, with an advanced cerebellar tumor syndrome of seven months' duration: headaches, projectile vomiting, loss of weight, anorexia, cerebellar ataxia, and choked discs.

At operation on October 6, 1927, a typical midline cerebellar medulloblastoma was cleanly extirpated, chiefly by suction, leaving the floor of the fourth ventricle fully exposed. The patient made a good recovery from this operation and was subsequently given X-ray treatments over the entire cerebrospinal axis at intervals of from two to four months. For the first year she remained wholly free from symptoms.

She was readmitted to hospital July 29, 1929, because of the abrupt accession of symptoms of a week's duration. A series of six X-ray treatments were then given and she was again discharged. For the first time, no improvement followed this series of radiations and on September 21, 1929, she was again admitted to hospital. She had become apathetic, incontinent, and emaciated. There were daily attacks of vomiting, feeding was a difficult problem, there was a constant slight pyrexia.

In spite of her desperately poor condition, a re-exploration of the cerebellar region was made on October 10. This was disappointing in that it failed to disclose the expected local recurrence, the fragment of tissue that was removed after redividing the vermis proving, under supravital preparation, to be wholly degenerated tumor. In the course of the operation clear fluid had been obtained by a puncture of the cerebellar ventricles, and this, on examination, failed to show any tumor cells.

¹ Case 50 of medulloblastoma series as reported. *Acta Path. et Microbiol., Scand.* 1930 vii, 1-85.

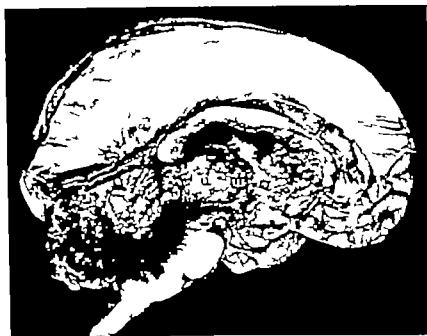


Fig. 5. Case 6. Note invasion of medulla and massive obliteration of cerebral ventricular system by recurrent medulloblastoma.

Following this futile procedure, the child's critical condition remained unchanged. In the subsequent bedside notes, attention was called to her abundant perspiration which was limited almost wholly to the right side of the face. She gradually passed into coma and died on October 27 at 2:43 p.m. with a terminal hyperthermia (106.5 degrees). An unrestricted post mortem examination was held one hour later.

Autopsy 3:45 p.m. (Dr. Schult). Two striking things were disclosed: (1) a massive intraventricular involvement by tumor (Fig. 15) in the absence of macroscopical evidence of tumor implantation in the spinal or cerebral meninges, and (2) a chronic duodenal ulcer. The esophagus and stomach were wholly normal in appearance, the mucosa being well preserved, but in the first portion of the duodenum, 3 centimeters below the pyloric sphincter, was a small ulcer measuring 3 by 4 millimeters. It had a firm, elevated margin and depressed center forming a crater. The lower bowel elsewhere was apparently normal.

Microscopical examination of the ulcer shows that it extends down to the muscularis, that its margins are steep and slightly undermined (Fig. 16). On its floor there is a narrow zone of dense hyalinized connective tissue, and in one region some fibrin and necrotic tissue. Within the excavated crater lie desquamated epithelium and blood elements. The scar tissue at the rim of the ulcer shows chronic inflammatory cell infiltration. In the adjacent tissue are

small thrombosed blood vessels filled with fibrin and a few polymorphonuclear leucocytes (Fig. 7).

In this case a large recurrent thoroughly radiated medulloblastoma filled the cerebral intraventricular system. The child had been subject to frequent attacks of sudden vomiting, but as this is characteristic of most cerebellar tumors, its possible association with a peptic ulcer was not suspected nor were any studies made in this direction. During the course of cerebellar operations on patients under local anesthesia it is well known that vomiting may be easily provoked and this is commonly ascribed to stimulation of the vagal nucleus in the floor of the fourth ventricle. What is more, all neurosurgeons are familiar with the fact that after major intracranial operations the vomitus for the first few days may show evidences of changed blood. While this is usually attributed to the swallowing of blood from some source during the progress of the operation, it is highly probable that it may be due more often than is commonly supposed to acute neurogenic erosions.



Fig 16 Case 10 Showing duodenal ulcer (mag $\times 20$) in child associated with tumor metastasis involving third ventricle (cf Fig 15)

Though I am not aware of any other examples in my tumor series of the postmortem finding of a chronic ulcer, we not infrequently see in the hospital wards patients recovering from serious intracranial operations in whom during convalescence digestive disturbances are in evidence which strongly suggest incipient ulcer symptoms. But this perhaps is true no less of operations of other sorts. Somewhat more definite is the fact that a goodly number of patients with symptomatic evidences of an organic lesion in the region of the third ventricle have had a roentgenologically demonstrable gastric or duodenal ulcer. The following example will serve in illustration.

CASE 11 (Surgical No 34129) *Tumor of third ventricle (demonstrated by ventriculography) causing pressure symptoms associated with gastro-intestinal disturbances. Subsequent periodic radiation of lesion with marked improvement. Recurrent duodenal ulcer.*

Edward C., an electrician, aged 25 years, was admitted June 5, 1929. Apart from periodic indiges-

tion, to which scant attention was paid, he had enjoyed uniformly good health. Suddenly, on May 12, 1929, fatigued by a 200 mile motor car drive, he had a sudden severe occipital headache with vomiting. A succession of these occurrences followed and he was soon obliged to give up work. The seizures which came in paroxysms were characterized by retraction of the neck, dizziness, sweating, protrusion of the eyes, and painful flexure of the arms, they would terminate with a cough or a yawn when sudden relief would be experienced. He was taken to a hospital on May 31 and treated for "gastric symptoms." While under observation, he acquired a diplopia with choked disc and was transferred to the Brigham Hospital as a brain tumor suspect.

Examination. This showed a man with a rigid neck, a bilateral abducens palsy more marked on the right, and a choked disc of 4 diopters. The reflexes were hyperactive, with a bilateral Babinski. Ventriculograms disclosed a symmetrically disposed hydrocephalus with a filling defect of the third ventricle and a block of the foramina of Monro. He was given a series of four X-ray treatments, began promptly to improve, and the choked discs rapidly subsided. He was discharged June 23 practically symptom-free and two weeks later resumed his occupation.



Fig. 7 Case 6. Showing, from squared area in Figure 6, thrombosed vessels and clotted areas of necrosis in lower right part of field (mag. $\times 100$)

He remained well for over a year when he once more began to have "nervous indigestion" associated with nausea and hunger pangs for which he finally reported to the ambulatory clinic. Suspecting that these symptoms might be due to a recurrence of the intracranial lesion, and as the patient was unwilling to re-enter the hospital for study the attendant recommended further radiation of the third ventricle and on February 18, 19, and 21, 1931 three additional treatments were given. After an interval of two weeks, the symptoms again disappeared and he was lost sight of. No dietary restrictions had at any time been imposed.

Eleven months elapsed when on January 12, 1932 he again reported to the clinic stating that his gastric symptoms had recurred and he wished to have more X-ray treatments. Because the symptoms were so suggestive of ulcer barium studies were made and a typical active duodenal ulcer was disclosed. As he was unwilling to enter the hospital to have his ventriculograms repeated, he was given another series of radiotherapeutic treatments on January 18

19, 20 and 21 directed to the third ventricle. Within three days after the last session, the symptoms of indigestion had wholly disappeared and he returned to work. He reported on request, March 5 for barium studies which showed the trace of a healed ulcer unassociated with local tenderness. He was symptom free and could eat the most indigestible articles (e.g. cabbage) without discomfort.

Here, then was a symptomatic and roentgenologically demonstrable duodenal ulcer associated with a symptomatic and roentgenologically demonstrated tumor of the third ventricle. The growth fortunately proved to be susceptible to the effects of roentgen therapy and when pressure symptoms were thereby relieved the gastric symptoms promptly subsided. Indeed, in the absence of any actual return of intracranial symptoms, therapeutic radiations of the third ventricle have on two subsequent occasions had a prompt and long enduring effect in checking the recurrent symptoms of the ulcer.

Other examples of symptomatic and roentgenologically demonstrable ulcer have been encountered in association with diabetes insipidus and with tumors of the nervus acusticus but it is need less further to pile up the evidence drawn from a single clinic, particularly since the relation of organic intracranial disease to peptic erosions or ulcers will come

up for later discussion

II. PATHOGENESIS OF PEPTIC ULCERATIONS

A satisfactory all-embracing explanation of acute or chronic ulcerations of stomach and duodenum is yet to be found. From the first it has been a highly controversial subject regarding which there are many divergent views. Until an acceptable explanation is reached we cannot look forward to the prevention of ulcer and physicians and surgeons will continue to differ widely in their views regarding the proper therapeutic regimen to follow in its active stage and how to forestall its tendency to recur when once healed. What is more, even those surgeons who believe that most ulcers should be operated upon differ in the procedures which they advocate for its

cure or alleviation. It, indeed, is doubted in some quarters whether hæmorrhagic erosions (*cf.* Cases 4 and 5) or acute perforative lesions (*cf.* Cases 1, 2, 3, and 7) or gastromalacia (*cf.* Cases 8 and 9) are in any way related to chronic ulcer, it being the fashion just now in some foreign clinics to ascribe ulcer, as Cruveilhier did long ago, to an antecedent gastritis.

The literature of ulcer pathogenesis is enormous. In his review of the subject [6] in 1911, Moeller cited 325 references, and this number in the intervening two decades has probably been quadrupled. Based on experiment or on experience at bedside and operating table, pathologists, physiologists, pharmacologists, and clinicians have offered innumerable explanations. Old hypotheses long forgotten are from time to time revived with some slight modification, and the fact that in defence of each one of them a strong brief could be written means that in all probability more than one causative element must be concerned. It indeed is quite possible that the several hypotheses—vascular, traumatic, secretory, toxic, bacterial, biochemical, and so on—are capable of being harmonized.

Most of the attempts experimentally to produce in the lower animals peptic ulcers have been made on the stomach itself under the assumption that the disorder is essentially a local one. Erosions and occasionally chronic ulcers have thus been produced by a great variety of procedures which in most instances are remote from the circumstances in which ulcer so commonly occurs in man. Attention, indeed, has been so largely confined to the local search for an explanation of the lesions that their ease of production by injuries of the central nervous system has been largely forgotten though it is an old story. In his discussion of ulcer pathogenesis in 1885, Professor Welch stated [7] that "the neurotic theory of the origin of gastric ulcer is altogether speculative and has never gained wide acceptance." While this view is generally held at the present day, the evidence in favor of the theory is nevertheless accumulating and in the succeeding sections I shall endeavor to draw it together as briefly as circumstances make possible.

a Neurogenic versus local Explanations

In a section of his celebrated *Handbuch der pathologischen Anatomie* (1841-1846)¹ dealing with "the ulcerative processes of the stomach," Carl Rokitansky described with unsurpassed clearness, brevity, and detail all the processes that have been illustrated in the eleven cases given above—acute perforating ulcers, hæmorrhagic erosions and the simple chronic ulcer. He also described two forms of acute softening which he sharply distinguished from cadaveric softening or self-digestion of the stomach. The first of them, a gelatinous softening, occurs in the newborn and is frequently associated with a demonstrable intracranial lesion, hence, "the proximate cause may be looked for in diseased innervation of the stomach, owing to a morbid condition of the vagus, and to extreme acidification of the gastric juice." Of the second form of softening he distinguishes two types: one of them "occurs, both in children and adults, as the sequel of acute affections of the brain or its membranes, and is probably brought about by a reflex action of the œsophageal and gastric branches of the vagus", in the other type associated with cachectic states, the stomach contains large quantities of "coffee-ground" fluid which is often vomited during life. Softening of this latter type often attacks the lower third of the œsophagus (*cf.* Case 3) leading to perforation and effusion into the left thorax. He admits that a conscientious pathologist may find difficulty in distinguishing between cadaveric softening and morbid softening unless he take the clinical history and mode of death into consideration.

Thus, so far as I can gather, is the first definite suggestion that any of the ulcerative processes under discussion may have a neurogenic origin. So far as chronic ulcer is concerned, Rokitansky does not go further than to state that it probably commences as an acute circumscribed hæmorrhagic erosion which increases by sloughing and exfoliation layer by layer, and is invariably accompanied by a chronic catarrh of the mucous membrane.

Though his works are no longer read and his reputation as a pathologist was soon to be

¹The third volume in which the pathology of the organs of nutrition is considered was the first to be published (1841).

eclipsed by the greater fame of Virchow Rokitsansky's teaching based on a vast experience gained at the autopsy table made a deep impression on his contemporaries which still endures. Thus for example, there survives in Vienna, whence it has spread into many pathological laboratories throughout the world, a tradition of the deadhouse, in effect that autolytic destruction of the stomach is most often found in the bodies of persons who while digesting have died from an intracranial disorder particularly when it was associated with a terminal fever of high degree. Beyond this the general subject of gastric erosions or of gastromalacia arouses no present-day interest and is scarcely mentioned in contemporary textbooks on pathology. That it has any possible bearing upon or any possible relation to chronic peptic ulcer is no longer even suggested.

Traceable to Virchow is the concept that ulcer is essentially a local process and out of this has come the highly unprofitable search for its primary cause in the walls of the stomach itself—a search beset by pitfalls and contradictions. The discredited view of Rokitsansky on the other hand, that the disorder has a neurogenic source has slowly but surely gained ground¹ as our knowledge of the vegetative nervous system and its cerebral connections has increased. His influence may be traced in four more or less independent directions which deserve separate consideration. The first of them leads to the association of brain tumor and ulcer in regard to which, so far as I can observe, he made no allusion; the second concerns the gastroduodenal ulcers and erosions of infancy; the third leads to the experimental production of ulcer by lesions of the nervous system and the fourth to concepts concerning ulcer production which have been looked upon as somewhat fantastic though based securely on pharmacological

grounds. The last of these four currents of thought is the most important but to the others some reference however brief may in turn first be made.

b Ulcers and Intracranial Disorders

In most of the eleven cases assembled to illustrate this report the surgical procedure and not the tumor was looked upon as the provocative cause of the lesions in the upper alimentary canal. The exceptions were the two cases of hypertension with choked disc (Cases 6 and 7) the man (Case 11) with an unverified tumor of the third ventricle, and the child (Case 10) with intraventricular metastasis. As a matter of fact, in the absence of operative intervention, acute or chronic ulcers are known to accompany intracranial tumors, when properly situated to produce them more often than can be explained by mere coincidence. The remarkable thing is that the combination of the two lesions should occur at all and be found postmortem for an acute perforative gastric lesion is so obviously the immediate cause of death the brain may not be examined or should an obvious intracranial tumor lead to a fatal issue, permission for a postmortem examination is likely to be restricted to an examination of the brain alone.

Not only therefore are the combined lesions—brain tumor and ulcer—unlikely to be observed, one masking the other but, what is more when observed and reported they are not easily located. Nevertheless, a few examples, old and recent may be given. In 1868 Professor Carl Hoffmann of Basel (8), one of the early upholders of the view that softening (oesophago- or gastromalacia) was a process which began before death, described two cases of oesophageal perforation in adults with antemortem signs of peritonitis. The second case had definite intracranial symptoms and was found at autopsy three and a half hours after death to have a gummatous, interpeduncular tumor with softening of the right half of pons and medulla.

In 1874, Rudolf Arndt, the Greifswald psychiatrist, in illustration of the fact that functional disturbances may produce symptoms remote from the seat of organic disease, reported the case [9] of a 26 year old woman

¹ In his brief discussion of ulcer in the stomach recently quoted (Virchow's Arch. 1912, p. 261), Virchow makes no reference to Rokitsansky and merely refers to recent articles by Grossberg (Arch. f. physiol. Heft. 1912, 11, 196-217) who on the basis of a double blind test, more extensive histopathologic dissection, more numerous possible vaginal perforations as ulcer leads to death which Rokitsansky had proposed eleven years before. It is probably because of this that Grossberg's views have not been so completely refuted by us, for example, by Kugel in his paper in the *Annals of the Department of Medicine* (New York Academy of Medicine, 1920, 1, 217 et seq.) who quotes Grossberg's views that the histological destruction of the gastric mucosa is of the primary character from quantitative analysis of the processes of free acid.

with nutritional disturbances, somnolence, amenorrhœa and vomiting, who died from the effects of a walnut-sized sarcoma of the meninges occupying the interpeduncular space at the base of the brain. There was also disclosed, during the examination, a hyperæmic softening of the stomach with numerous ecchymoses of the fundus, a condition which was ascribed to a reflex disturbance of vagal innervation. Aware that this was not a very convincing case, some years later Arndt reported another example [10]—that of a man of 55 with cerebellar symptoms and Cheyne-Stokes respiration who was found after death to have a median cerebellar tumor compressing the corpora quadrigemina and medulla together with a markedly hyperæmic and ecchymotic lower œsophagus and duodenum in association with ecchymoses, extravasations, and hæmorrhagic erosions of stomach. On the basis of these findings, and of the experiments of Schiff and of Epstein to be referred to later on, the author suggests that round ulcer is an angioneurosis or trophoneurosis, the acute erosions being regarded, in agreement with Rokitsky, as an early stage of the chronic form of ulcer.

Scattered through medical literature under various titles may be found other examples. In a study of the source of postoperative hæmatemesis observed in von Eiselsberg's clinic after surgical operations, von Winiwarter [11] stated (1911) that in two unaccountable instances fatal bleeding from the stomach had followed intracranial operations, and in view of my own experiences it is curious that both of them were suboccipital operations for supposed cerebellar tumors.

Subsequently, pathologists in various university centers began to show a renewed interest in these matters. Thus, in 1908 [4] Professor Beneke of Marburg, in a study of the causes of "black vomit," furnished statistics concerning gastric erosions and ecchymoses observed in 293 autopsies on medical cases, and though the statistics are somewhat difficult to appraise, the two largest single groups accompanied by erosions were represented (1) by diseases involving organs adjacent to the stomach, and (2) by a group of sixty intracranial disorders, to which ten

others classified as "shock in the newly born" might well be added. In 1910 Professor Roessle of Jena made the interesting suggestion [12] that ulcer was commonly a secondary disease (*zweite Krankheit*), reflexly produced through irritation of the vagus by a primary disease elsewhere. Acting upon this idea, in 1918 Professor Carl Hart, of Berlin [13], attempted to determine the relation, if any, between peptic ulcer and remote disorders, and he found to his surprise that 17 per cent of the ulcers disclosed postmortem during a period of four years were associated with affections of the brain—a percentage exceeding that in which cardiovascular disorders, tuberculosis, or cholelithiasis represented the "*erste Krankheit*."

Still more important have been certain studies emanating from the University of Moscow, where, under the leadership of the pathologist, Mogilnitzky, particular attention has been paid to the relation to ulcers of intracranial lesions definitely affecting the interbrain, more particularly the corpus Luysi. In 1925 [14] he briefly mentioned four examples of fatal intracranial disorders associated with gastric ulcer, and three years later his pupil, Korst [15], after mentioning that Mogilnitzky had observed eight cases of tumor of the mid- or inter-brain with gastric or duodenal ulcer proceeds to give three other highly interesting examples. One of them was a frontal lobe tumor involving the basal ganglia in which degenerative processes were observed in the right hypothalamic nucleus on the corresponding side, the second case, a three year old child, had an ependymal tumor of the fourth ventricle which had compressed the vagal nucleus and caused a marked hydrocephalus, all the vegetative nuclei of the third ventricle being found degenerated, the third case was one of hydrocephalus associated with sclerosis of the brainstem and a complicating meningitis. In all three instances hæmorrhagic erosions of the gastric mucous membrane were found after death.

c Ulcerative Processes in Infancy

Five years after Rokitsky's observations were published there appeared a monograph [16] by Elsaesser on autodigestion of the

stomach as it occurs in the newborn and this much quoted article served to revive the polemics between representatives of the Berlin and Vienna schools as to whether the process was purely cadaveric or whether it started *intra vitam*. Elsässer's report was based on the study of thirty-eight examples which he had observed many of them having been found in association with intracranial disorders but he emphasizes that erosions and softening occur only when the stomach is actively digesting at the time of death. Though the postmortem examinations in all instances were delayed for twenty four hours or longer autodigestion was never observed except under the conditions mentioned.

The bearing of all this upon the erosions, perforations, and ulcers of the newly born, often associated with melena neonatorum, appears to be very largely overlooked or forgotten, due possibly to the fact that immediately after parturition the mother gets more attention than the child. There nevertheless has been a later-day revival of interest in the subject. In 1911 it was pointed out by Rudolf Pott [17] from Beneke's laboratory in Halle that intracranial birth hemorrhages are usually caused by lacerations of the dura near the junction of tentorium and falx resulting in extravasations of blood into the posterior fossa.

In several of the many reported cases, hemorrhagic mucosal erosions and occasionally hemorrhages into the adrenal glands were described in the autopsy protocols without any comment on their significance. In 1892 however the attention of Professor v. Preuschen of Greifswald was drawn to the matter by the example of an infant with melena who died on the second day after birth, the autopsy showing (1) a subtentorial hemorrhage with extravasation into the fourth ventricle and (2) hemorrhagic erosions of the gastric mucosa [18]. He was led to believe that an intracranial lesion might be a common cause of melena in infants, and in collaboration with Pomoraki then an assistant in Grawitz laboratory [19], experimental injuries of the hind brain were made in animals demonstrating the fact that erosions of the gastric mucosa were common sequels of such lesions.

Though the examples of gastromalacia described by Elsässer and the erosions of v. Preuschen mentioned above have been acute lesions, ulcerations of more chronic type which occur in the duodenum of infants and which are roentgenologically demonstrable, have more recently been the object of attention. Emmett Holt, in 1913 made a careful study of the subject [20] and two years later Gerdine and Helmholtz [21] recorded a series of eleven infants who before death had shown blood in vomitus or stools, duodenal ulcerations occasionally with perforations having been found at autopsy in all instances. Whereas v. Preuschen after due consideration discarded as improbable the bacterial origin of ulcer in the newly born, Gerdine and Helmholtz warmly supported their colleague Rose now's well known views in this regard, all of the lesions which were histologically examined having shown diplococci or streptococci. Attention however may be drawn to the fact that in the only three instances in which the brain was examined meningitis was the cause of death and it may also be noted that streptococci and staphylococci are organisms normally found in the upper part of the alimentary canal.

In the series of cases that I have reported, only three were children, one of whom was found to have had a perforation of the oesophagus. When this was called to the attention of my colleague, Professor K. D. Blackfan, he kindly looked into the matter and somewhat to his surprise, I believe, found in the autopsy series for 1931 at the Children's Hospital in Boston four examples of death from oesophageal perforation associated in all instances with an intracranial lesion (occlusion of the aqueduct of Sylvius with hydrocephalus 1 meningitis 3). In all instances vomiting had characterized the malady and in one at least it contained large amounts of changed blood.

In his *Textbook of Diseases of the New Born* (page 448) Von Reuss states that melena occurs more frequently after prolonged and difficult labors and suggests that cerebral birth injuries may predispose to erosions and it is of course, well known, as Helmholtz and others have pointed out, that the roentgeno-

logically demonstrable duodenal ulcers in infants and children are prone to heal and probably therefore are often overlooked¹

d Experimental Neurogenic Ulcerations

So far, the argument favoring the neurogenic production of erosions and ulcers may appear somewhat lame, based as it has been (1) on the lesions which have been seen to occur as a sequel to certain intracranial operations, (2) on the occasional accompaniment of intracranial tumors and ulcers, and (3) on the occurrence of ulcerative processes in the newborn in association with cerebral birth injuries or intracranial disorders of other kinds. The issue has been largely a difference of opinion over the question, on the one hand, whether the erosions and softenings were in any way related to chronic ulcer, and, on the other, whether they were wholly cadaveric lesions or were attributable to processes which were already under way at the time of death. We now come to something more definite, namely, the consequence of experimental lesions, and it may be best to consider separately (1) *the effect of lesions of the peripheral nerves to the stomach* and (2) *the effect of lesions of the brain*

I Peripheral lesions of vegetative nerves
Rokitsansky, as has been told, assumed that the intracranial disorders to which he attributed ulcer acted in some way through the mediation of the vagus and this naturally led at many hands to a vast amount of experimental work with highly contradictory results. What is more, reports were made from time to time of gastric ulcers in association with an involvement of the vagus by some pathological process such as a tuberculous lymph node or mediastinal tumor. It has been found in laboratory animals that erosions, at least, may be produced in rabbits or dogs either by stimulating or dividing one or both vagi, whether above or below the diaphragm, and

not only this but the same effects appear to follow stimulation or resection of the splanchnic nerves or coeliac plexus whence pass the sympathetic nerves to the stomach.

On wading through the literature of the subject, no possible order would seem to come from this chaos. But if the elementary fact is borne in mind that the thoraco-lumbar (sympathico-adrenal) system of Gaskell and the cranio-sacral (autonomic) system of Langley represent, as Hans Meyer has shown, a nicely balanced dual mechanism, the visceral effects of the two systems being antagonistic one to the other, it becomes apparent in spite of the many contradictions, that the peripheral lesions which have led with the greatest constancy in the laboratory to ulcerative lesions have either been paralytic on the part of sympathetic nerves or stimulatory on the part of the vagus.

Most of the experimental procedures, naturally enough, because of their greater ease of production have been paralytic in nature, and though vagal section whether above or below the diaphragm has led to erosions and acute ulcerations at many hands, it is possible that, in the process of paralyzing the nerves, a primary stimulatory effect may actually have been produced. But however this may be more consistently successful results have followed severance of the splanchnic nerves or extirpation of the coeliac plexus—[e.g., dalla Vedova, 1900 (22), Durante, 1916 (23), and Gundelfinger, 1918 (24)], or from bilateral adrenalectomy [e.g., Finzi, 1913 (25), Gibelli, 1909 (26), and Mann, 1916 (27)].

The effects of long continued peripheral nerve excitation are far less easily investigated. Nevertheless, successful attempts have been made in this direction. Thus Keppich in 1921 [28] produced gastric ulcers showing definite tendency to chronicity in ten out of eleven rabbits by placing electrodes on the vagi near the cardia and leading them out over the animal's back so that the nerves could be intermittently stimulated over periods from five to twenty-five days. And more recently Stahnke in 1924 [29] avoiding the complicating effects of a primary operation stimulated the vagi in dogs near the cardia by placing his electrodes in the lumen of the

¹ Another condition deserving of mention in this connection as a possible or probable secondary disorder rather than primary anomaly is the so called hypertrophic stenosis of the pylorus in infants. That this may be an expression of hypervagotonus resulting in muscular hypertrophy from spasm rather than a congenital anomaly has been suggested but never given full credence. Prof. Lehmann of Frankfurt a.M. (Ztschr. f. Kinderh., 1931 I, 691-701) has pointed out that it occurs not infrequently in association with megacolon, cardiospasm, congenital dilatation of the bladder and so on—conditions which may likewise be looked upon as a consequence of hypertonicity in the cranio-sacral autonomic.

lower oesophagus with resultant hypermotility, hypersecretion, pylorospasm chronic gastritis and ultimate erosions.

So far as the stomach is concerned, on this working basis of imbalance between sympathetic and parasympathetic systems, it is known that vagal stimulation causes increased motility and secretion, whereas sympathetic stimulation gives reverse effects and as a natural corollary vagal paralysis diminishes secretion and motility whereas sympathetic paralysis increases them presumably by releasing the vagus from the check normally exercised by the sympathico-adrenal apparatus against its overaction. On these general principles is based the surgical division of the left branch of the vagus as it passes to the stomach wall—a procedure advocated for ulcer patients showing high pre-operative free acidity with hypermotility and routinely practiced by some surgeons both in this country [30] and abroad with results said to be, at least temporarily excellent.¹

2 Lesions of Vegetative Tracts in the Brain

In 1845 three years after Rokitanaky's views became known, Moritz (Maurice) Schiff a brilliant and highly original pupil of Magen die's, made the interesting observation [31] that a unilateral cerebral lesion in dogs and rabbits involving optic thalamus and adjacent cerebral peduncle would often lead after a few days, to softening of the stomach and occasionally to actual perforation. Schiff ascribed this to a patchy (*en plaque*) neuroparalytic hyperemia of the gastric mucous membrane brought about by injury of the central pathway for vasomotor nerves to the stomach. He subsequently observed also [32] that a unilateral division of the pons or of the medulla as far back as the calamus scriptorius, and also that hemisection of the two upper segments of the spinal cord, would cause the same effect. Whether unilateral division of the cord lower down or injuries of the sympathetic nervous system would produce lesions of the same kind he was unable to determine as the animals failed to survive. Nevertheless, by this in-

genious series of experiments, he was able to trace the course of the vasomotor nerves of the stomach (*sic*) from the thalamus to the commencement of the cervical cord. He also observed (1) that stimulation of the corpora quadrigemina, the cerebral peduncles, the pons, and cerebellar peduncle caused gastric movements comparable to those elicited by vagus stimulation (2) that these movements were blocked by division of the vagi and (3) that stimulation of the splanchnics and more particularly of the coeliac plexus, caused contraction of the vessels of the stomach.

Schiff's final views regarding these matters were published in 1867 in his celebrated "Lectures on the Physiology of Digestion" [33]. In general terms, he recognized that there were vasoconstrictor and vasodilator fibers to the stomach that the former passed by way of the coeliac plexus whereas flushing effects were produced by stimulation of fibers in the pneumogastric. It requires little imagination reading between the lines of his discussion to foresee the present-day distinction between counterbalancing sympathetic and parasympathetic systems, both of them under the control of higher centers which Claude Bernard located in the medulla but which modern views, as will be seen, tend to place in the hypothalamic nuclei of the Interbrain.

Schiff's experimental observations were soon repeated and essentially confirmed by others. In November 1875 Brown-Séquard [34] before the *Société Anatomique* exhibited the stomach of an animal which had died from the effects of a chronic perforative gastric ulcer produced by an injury (cauterization) of the cerebral cortex. While upholding Schiff's views in general he distinguishes between softening and hemorrhagic lesions which latter he found to be a uniform consequence of experimental injuries at the junction of the middle cerebellar peduncle and the pons.

More fully reported were the series of contemporary experiments carried out by Wilhelm Ebstein [35] then director of the Medical Polyclinic in Breslau. By injecting chromic acid he made small unilateral punctate lesions alongside the anterior corpora quadrigemina without injury to the adjacent peduncle and in nine of twenty three animals succeeded in

¹ It has since been observed that gastric acidity may return in course of months or years after experimental double vagotomy even when associated with substantial gastroscopy indicating highly efficient conservative mechanism (cf. Shapiro, P. F. and Borg, R. M. *Proc. Soc. Exptl. Biol. & Med.* 14, 2226, 742-743).

producing ulcerative erosions. He also got similar though more delayed effects by unilateral lesions of the thalamus, medulla, and of the upper cervical cord, but found complete transection of the cord to be without effect on the stomach. He attributed this negative result to the consequent lowering of blood pressure whereas the intracranial lesions, presumably from stimulation of a vasomotor center, elevated the blood pressure leading to submucosal extravasations of blood which permitted the corrosive action of the gastric juice locally to take effect.

Similar experiments were conducted some twenty years later by v. Preuschen and Pomorski [18, 19] as an outcome of their interest in *melæna neonatorum*. Pulmonary and gastric hæmorrhages were produced by punctate lesions of the *crura cerebelli*, *corpora quadrigemina*, pons and floor of the fourth ventricle in rabbits. Their most constant results, however, occurred when chromic acid was injected into the right anterior colliculus, only two failures to get ulcerations after ten hours having been observed in eleven animals with lesions made in this situation.

More recently (1925-1926) the matter has been taken up anew by Prof. Mogilnitzki and his surgical colleague Burdenko of the University of Moscow [36]. With the object of stimulating or paralyzing vegetative nervous centers in the diencephalon, more particularly the corpus Luysii which they assumed to be the pathway for vasodilatation, they made lateral punctures into the hypothalamic region and observed in stomach and duodenum not only hæmorrhagic erosions and perforations but also in some instances chronic cicatricial ulcerations. Thus, from the time of Schiff, unilateral lesions, which in some way have affected not only the presumptive source of vegetative (vagal) impulses in the hypothalamus but the supposed pathway of the fibers from this region backward as far as the medulla and upper cord, have in the hands of several investigators led to ulcerative processes in the stomach or duodenum with fairly consistent regularity.

Most of these experiments, as will have been noted, have been made in rabbits, an animal particularly prone to show gastric erosions

under a great variety of circumstances, and what is more, the lesions in most instances have been without evidence of chronicity. A far more telling series of experiments has recently been carried out by Dr. Allen D. Keller, professor of physiology in the University of Alabama, who has kindly permitted me to give the following brief reference to his unpublished observations.

In a study primarily undertaken to throw light on the heat-regulating mechanisms of the brain stem in cats, bilateral lesions were made in the expectation of freeing the hypothalamus from its connections with the brain stem. From these operations the animals recovered perfectly, showed no appreciable effects of the lesions, and appeared to be entirely normal in all respects. After the expiration of a few days, however, they refused food, had spontaneous vomiting, and died in from four to ten days. Postmortem examinations invariably showed gastric lesions ranging from simple hyperæmic areas to erosions extending through all the layers of the gut, and to punched-out perforating ulcers. The definitely delimited hyperæmic areas were always found at the terminal end of a small artery. The preliminary event, in other words, was a characteristic patch of hyperæmia resulting in a submucosal extravasation visible from both mucosal and peritoneal surfaces and which was definitely the precursor of the mucosal erosion.

Many of these observations, therefore, which are in line with the original concept of Rokitsansky tend to conciliate his views with those of Virchow in explaining how the local vascular lesion on which the gastric secretion acts comes to be brought about through neurogenic influences. None of the recorded cerebral lesions that have served experimentally to produce ulcer, except those of Burdenko and Mogilnitzki, have been made higher than the mid-brain, nor have they been sufficiently circumscribed, in want of knowledge concerning the precise pathway for the vegetative impulses, to permit us to determine whether the effects have been due to stimulation or to paralysis of efferent sympathetic or of parasympathetic fiber tracts.

That there are important nerve centers in the walls of the third ventricle was first emphasized by Edinger, and the recent painstaking studies, particularly by Rioch (1930), have served to locate them in minute detail. From a physiological standpoint, three principal

nuclear accumulations (Beattie) may be distinguished (1) the supraoptic cluster (2) the tuberal cluster and (3) the more posteriorly situated hypothalamic cluster from which pupillary responses, sympathetic in character can be electrically elicited. Stimulation of the tuberal nuclei on the other hand, appears to give parasympathetic (vagal) responses and there is considerable evidence from anatomical as well as physiological studies [54] that the active principle of the neurohypophysis exerts a direct influence on the tuberal as well as on the supraoptic cell clusters.

Though the course of the fibers from these hypothalamic nuclei backward toward the medulla and cord to emerge in the craniosacral autonomic periphery on the one hand, and in the thoraco-lumbar sympathetic field, on the other is still obscure, the matter has been attacked in various ways (1) by tracing the early embryonic development of the finely myelinated fibers coming from these nuclei which are among the first identifiable fibers to be laid down (Cajal Koelliker and von Gehuchten) (2) by the study of fiber degenerations after experimental lesions (Beattie, Brow and Long) and (3) by stimulatory experiments on serially decerebrated animals (Langworthy and Richter). Though much remains to be learned, the general course of the fibers is now sufficiently clear [cf Spiegel, (37) and Beattie, (38)] to make it apparent that the experimental injuries of Schiff, Ebstein, Keller and others have served to stimulate or injure the principal descending fiber tracts, but whether the secondary peptic lesions which are under discussion have been due to parasympathetic (vagal) stimulation or to sympathetic paralysis must remain conjectural until more precise information is at hand.

III. PHARMACOLOGICALLY GAINED INFORMATION

a. *Clinical Interpretations* Through the effect of drugs much of our knowledge of sympathetic and autonomic systems has been acquired. It began with Schmiedeberg's ob-

servation, made in Ludwig's laboratory in 1871 that after the injection of nicotine stimulation of the vagus quickened rather than slowed the frog's heart, and subsequently Langley and Dickenson demonstrated (1889-1890) that painting the paravertebral ganglion with nicotine or a nicotine-like substance (pituri) served effectually to block sympathetic impulses passing from the cord. That nicotine has a powerful vagotonic effect can be appreciated by all of those who remember the consequences of their first cigar and that on the part of habitués excessive smoking among other things is highly disturbing to digestive processes is well known to clinicians and fully recognized if not always admitted by the victims of ulcer themselves.¹

To Gaskell's pathfinding studies (1886) we owe our present conception of the thoraco-lumbar sympathetic (the sympathico-adrenal system of Cannon) but it was left for Langley to prove the existence of a separate "cranial outflow" and a "sacral outflow" (his oro-anal autonomic or parasympathetic system) the two systems being essentially different in their phylogenetic development and physiological activity [39]. But the conception that there exists in constant operation a physiological antagonism or balance between these two systems appears to have reached its development not in Cambridge but elsewhere. First clearly pointed out by Hans Meyer's pupils, Froehlich and Loewi [40] and subsequently elaborated by Hans Meyer himself [41] this concept became popularized by others who first and last, have been attached to the Vienna school.

So far as concerns the stomach, the action of adrenalin in checking motility and diminishing secretion is equivalent to a stimulation of the sympathetic apparatus. On the other hand, the action of other drugs, notable among which are pilocarpine and physostigmine, is equivalent to stimulation of the cranial autonomic (parasympathetic) system of which the vagi are the more important branches, and the effects are counteracted by atropin. The several drugs which serve as vagal stimulants are somewhat selective in their action on the

One might well expect that anatomical evidence of the so-called "autonomic (sympathetic) apparatus" would be the first to appear in view of the greater part in the early hours of a heart and blood vessel system. For such, digestion, and circulation, there are all apparatuses like the thoraco-lumbar sympathetic, used in the emergency of escape or combat.

1. Cf. Mergenhagen, B. Two lectures on gastric and duodenal ulcer. Medical Journal N.Y. 1934. 2. See Ltd.

divisions of the parasympathetic apparatus, whereas adrenalin, as Cannon has emphasized, acts explosively on the entire thoracolumbar system at one and the same time

Since there is no known paralyzant for the sympathetic system (unless ergotoxine may be such) counteractive to adrenalin as atropin counteracts pilocarpine, in studying the effects of lowered sympathetic activity recourse must be had to the experimental extirpation of the prevertebral chain, splanchnic nerves, coeliac plexus, or of the adrenal glands themselves. Sympathetic paralysis thus produced is equivalent in its effects to autonomic (parasympathetic) stimulation due to a release phenomenon, and on the other hand, parasympathetic paralysis theoretically is equivalent to sympathetic stimulation though the effects may be not so evident

A clinical application of this concept of counterbalance between sympathetic and parasympathetic systems, particularly in relation to the vegetative functions of the pneumogastric, was brilliantly presented [42] by Eppinger and Hess (1910), then colleagues of Hans Meyer in Vienna, in their monograph on "Vagotonia"—a treatise which gave a wholly new interpretation of certain kinds of "nervous invalidism." Vagotonic persons according to their thesis react with sweating and salivation to small doses of pilocarpine, they are apt to be asthenic, to have cardiac arrhythmias, and to show gastric hyperacidity these symptoms being invariably aggravated by pilocarpine. What is more, the "nervous dyspepsia," gastrosuccorrhœa, pylorospasm, cardiospasm and hunger pains to which vagotonic persons are prone are beneficially affected by atropin. Though Eppinger and Hess briefly discuss the relation of vagotonia to gastric ulcer, they do not expressly state that vagotonia predisposes to ulcer, but on the contrary seem to imply merely that persons afflicted by ulcer in the absence of hyperacidity, hypermotility and so on merely happen to be exempt from constitutional vagotonicity

The old idea, nevertheless, that a disordered action of the vagus had something to do with ulcer formation had from time to time been revived, and with the increase of knowledge concerning the relation of the nerve to the

digestive functions, the belief was held by some that chronic ulcer was the expression of a neurotrophic disturbance—a sort of mal perforans of the stomach. Thus in his discussion of Pavy's theory, that ulcer was due to a chemical imbalance brought about by lowered alkalinity of the blood, Wilks had stated that a neurogenic influence could no more be overlooked than it could in an obviously neurotrophic ulcer of the cornea, and similar ideas have been newly restated in view of the frequency with which ulcer has been observed in tabetics

But the general ideas formulated by Eppinger and Hess were first definitely focused on spasmodic peptic ulcer in 1913 [43] by Professor von Bergmann who emphasized (1) that the parasympathetic nervous system is disordered in ulcer, (2) that patients with ulcer respond to pilocarpine more markedly than do normal persons, and (3) that the long continued use of atropin will cure or ameliorate the familiar symptoms which accompany the disease

This ingenious explanation of ulcer has found favor not only with many clinicians but also with roentgenologists, notable among whom may be mentioned Martin Haudek, of Vienna [44]. In subsequent papers [45] on the subject, von Bergmann, while disclaiming that hypervagotonicity is the cause of *all* ulcers, asserts that they are more common in persons with a neuropathic constitution who show irritability of the secretory and motor functions of the stomach—in other words, in persons with an overactive parasympathetic nervous system. Thus, through a dysharmony or imbalance of the two divisions of the vegetative apparatus the local spasm leading to impaired vascularity of the mucosa that precedes erosions and ulcers is prone to occur

This novel conception of ulcer pathogenesis, like all other explanations, has found its prompt opponents. Loeper and Marchal [46], for example, in discussing the matter (1926) express the belief that the irritative disturbances on the part of the cranial autonomic system are the consequence rather than the cause of chronic ulcer, which they ascribe to the outpouring of leucocytes (*leucopédèse*) in the submucosa. Simnitzky [47] also (1926),

in calling attention to v. Bergmann's admission that stimulation of the vagus is more active in an acid milieu and of the sympathetic more active in an alkaline milieu, agrees with Bálint [48] (1926) in ascribing ulcer to primary acidosis of the tissues rather than to dystonia of the vegetative nervous system, which is reminiscent of the early conception held by Pavy and others of ulcer pathogenesis.

1 *Substantiation by peripheral action of drugs* Meanwhile von Bergmann's assistant, Karl Westphal [49] undertook to see if ulcer might not be produced in the lower animals by drugs known to stimulate the parasympathetic system. For this purpose pilocarpine and physostigmine were selected and given subcutaneously to rabbits in toxic doses (cats, dogs, and guinea pigs were less susceptible) localized areas of ischemic cyanosis being produced leading to erosions from subsequent action of the gastric juice on these vulnerable points. The lesions occurred, however only when the animal was actively digesting and when the contents of the stomach were acid.¹

These observations on pharmacologically produced ulcerations important and suggestive though they are, lie open to the same criticism that applies to other locally produced experimental ulcers in that they emphasize the effects of the drug on the neurosecretory end organs. That vagal stimulants like pilocarpine may appear to act with especial vigor on a parasympathetic center will now be considered.

2 *Substantiation by central action of drugs* Following the discovery by Karpilus and Kredl of the Vienna School in 1909 [50] that electrical stimulation of the hypothalamus (doubtless the posterior hypothalamus) caused pupillary dilatation, sweating, and other phenomena indicating a cerebral diencephalic center for the sympathetic nervous system, in

creasing attention has been paid to the functions of the hitherto much neglected interbrain. In 1925 the interesting observation was made by Cannon and Britton [51] that cerebral decortication in the cat led to an emotional state which they designated "sham rage" from its close resemblance to the behavior of the infuriated normal animal. A prominent feature of these emotional explosions was a mass discharge of the sympathetic nervous system with liberation of adrenalin. Bard [52] subsequently made it clear (1928) that this affective state in decorticated animals depended upon an intact posterior interbrain and Fulton and Ingraham in turn (1929) showed [53] that a chronic state suggesting "sham rage" was present in cats whose corticofrontal pathways to the interbrain had been surgically divided. Whereas Gaskell had looked upon the thoracolumbar sympathetic as largely a spinal involuntary mechanism and Langley had carried the cerebral stations of the cranial autonomic apparatus no further headward than the midbrain, these later-day disclosures, indicating that cortically uninhibited affective states emanating from the diencephalon can discharge the sympathico-adrenal apparatus, shed an entirely new light on the subject.

At another time and place [54] certain observations were reported on the effects of injecting posterior pituitary extract (pituitrin) and pilocarpine into the cerebral ventricles. When either the extract or the drug is thus introduced in susceptible (vagotonic?) subjects, it leads to stimulatory effects among which sweating, flushing, lachrymation and excessive sometimes blood tinged vomiting were notable features. These effects were interpreted as being essentially parasympathetic in nature and it was assumed, therefore that the parasympathetic as well as the sympathetic nervous system most probably had a primary nuclear representation in the interbrain.

Whereas pilocarpine supposedly acts exclusively on the nerve terminals, the human tests indicated a far more vigorous, central and presumably diencephalic action. It accordingly was suggested to my co-worker Dr. Richard Light, that he try to determine on

¹ Another drug, histamine, which may be regarded as parasympathetic stimulant in that it causes pronounced flushing with increase of gastric secretion, is more selective in character than pilocarpine in its sympathetic acts (Dale et al.) on the glands themselves rather than through their nerve supply and fails to increase gastric secretion. However, the results of the work of the Vienna School on the effects of histamine on the hypothalamus (Bálint, K. and others) have produced gastric ulcers in animals fed by the technique of Langley. They interpret the observations as being due to a purely humoral action of secreted "correlatives of histamine" due wholly to increased gastric acidity. This is a form of local spasm and the authors in their interesting paper (to be published) add that the correlatives disturbance may be brought about by impulses in the vegetative nervous system.

rabbits whether pilocarpine, introduced intraventricularly, would produce Westphalian erosions in smaller amounts than when given subcutaneously. In collaboration with C C Bishop and L G Kendall, this matter was put to the test [55], and it was found that even small doses of from 3 to 6 milligrams injected into the rabbits' ventricles produced erosions and that injections of 10 milligrams would cause them in 94 per cent of the animals, whereas 75 milligrams or more were needed to produce corresponding lesions with equal frequency when the drug was given subcutaneously.

The importance of these observations, in my estimation, lies not so much in the fact that a small dose (2 milligrams) of pilocarpine injected into the human ventricles has a prompt and widespread parasympathetic effect, as in the disclosure that pituitrin, when similarly administered, has a corresponding effect. What is more, the response to intraventricular pituitrin, surprisingly enough, is entirely different from the response which follows its intravenous or intramuscular injection. When introduced into the ventricles of susceptible persons, it causes flushing, sweating, salivation, and prolonged vomiting which, like the effect of intraventricular pilocarpine, can be checked by atropin or prevented either by preliminary atropin or by the narcotic drugs (e.g. tribromethanol and the barbiturates) which are known to inhibit the hypothalamic centers. When, on the other hand, pituitrin is injected subcutaneously, it causes pallor without sweating and promptly checks gastric peristalsis and secretion, its action in other words being entirely comparable to the effect of adrenalin.¹

The following roentgenological observations of gastric motility made in collaboration with my colleagues, Dr M C Sosman, and his assistant, Dr H F Hare, have thrown further light on the subject. After a barium meal, the gastric waves as they progress from cardia to pylorus have first been timed, and toxic

drugs or extracts have been then administered with results, briefly stated, as follows

A Intramuscular injection

1 Adrenalin (1 c.cm. of a 1:1000 solution) causes an almost immediate cessation of all visible movement for 20 minutes or longer.

2 Pituitrin (1 c.cm. "surgical") has precisely the same effect on the stomach as adrenalin, with cutaneous pallor.

3 Pilocarpine (12 mgm.) also causes a definite diminution of motility associated with moderate sweating.

4 Histamine (1 mgm.) causes a cutaneous flush without sweating and no visible change in gastric motility.

B Intraventricular injections

1 Adrenalin (not tried)

2 Pituitrin (1 c.cm. "surgical") promptly accelerates motility and soon causes retrograde peristalsis with retching and vomiting which can be checked by atropin. Other effects are sweating and flushing.

3 Pilocarpine (2 mgm.) causes prompt activation of motility, spasm of pylorus, retrograde peristalsis, prolonged retching, and vomiting. These effects which are associated with a drenching sweat, a cutaneous flush and fall in temperature can be checked by atropin. Vomitus shows increased gastric acidity and positive guaiac test for blood.

4 Histamine (2 mgm., two observations). No visible effect on peristalsis. Sense of fullness in head, dry mouth, no flush, no vomiting.

The assumption that these striking consequences of intraventricular pilocarpine and pituitrin were produced by local stimulation of a center for parasympathetic discharges, has received support from recent observations by Beattie (1932). He has shown [56] on animals that direct electrical stimulation of the region of the tuberal centers in the infundibulum causes not only increased gastric peristalsis and secretion, but, if long continued, leads to small hæmorrhagic ulcers of the mucous membrane near the lesser curvature. After section of the vagi these gastric effects were not obtained.

Thus, the reaction of the stomach to the intraventricular injection of either pilocarpine or pituitrin in man and to direct stimulation of the tuber in animals is hypermotility, hypertonicity, and hyperchlorhydria these three factors being those that commonly persist in cases of chronic gastric ulcer.

Eppinger and Hess, taking their cue from Langley, did not venture in 1910 to place the

¹ So far as I am aware there is no other instance of a drug or extract which has contrary effects when administered in different regions of the body, but next to nothing is known of the effects of drugs directly applied to the diencephalic nerve centers. In view of the sensitivity of the vagus nuclei in the fourth ventricle to exceedingly dilute solutions of emetin or apomorphin it is reasonable to assume that painting the walls of the tuber cinereum with one of these drugs will produce the same or an even more vigorous effect on the stomach.

autonomic control of the vagus higher than the midbrain and felt obliged to postulate the existence of a substance or hormone termed "autonomin" whose continuous activity preserves the normal tonus in the smooth muscles of the vegetative organs—a substance bearing the same relation to the autonomic (parasympathetic) system that adrenalin bears to the thoracolumbar sympathetic. That the secretory hormone of the neurohypophysis (pituitrin) in view of the observations mentioned above may represent their hypothetical autonomin is not improbable and the idea at least provides a working basis for further study.

IV. SUMMARY AND CONCLUSIONS

The attempt to find a reasonable explanation for the acute perforative lesions affecting esophagus, stomach, and duodenum which in three instances caused early fatality after operations for cerebellar tumor has led not only to a review of the extensive literature on the neurogenic aspects of ulcer pathogenesis, but also to certain experimental observations that strongly suggest the presence in the diencephalon of a parasympathetic center. From this center apparently tubular in situation, fiber tracts pass backward to relay with the cranial-autonomic stations of midbrain and medulla of which the vagal nucleus is by far the most important because of its influence upon the activity of the lungs, heart and upper alimentary canal.

Experimental lesions anywhere in the intracranial course of these fiber tracts from anterior hypothalamus to vagal center presumably from parasympathetic stimulation (or possibly from vagal release due to sympathetic paralysis) are prone to cause gastric erosions, perforations or ulcers (Schiff, Ebbstein and others). Intracranial injuries and diseases affecting these same basilar regions of the brain are known to be accompanied by ulcerative lesions of the upper alimentary canal. It is reasonable to believe, therefore, that the perforations following the cerebellar operations forming the basis of this study were produced in like fashion by an irritative disturbance either of fiber tracts or vagal centers in the brain stem.

Stimulation of the postulated parasympathetic center by intraventricular injections of pilocarpine or pituitrin cause in man an increase in gastric motility, hypertonus, and hypersecretion leading to retching and vomiting which ultimately contains occult blood. The same effects associated with observable patches of hyperemia of the gastric mucous membrane have been shown (Beattie) to follow direct electrical excitation of the tuber cinereum in animals.

The active principle of the neurohypophysis (pituitrin) demonstrable in the tissues in the form of hyaline bodies, is known to find its way through the infundibular stalk to the region of the nuclear cell masses of the tuber either by direct migration (Edinger-Collin) or by the intermediation of blood sinuses (Pope and Fielding) and the secretory product may possibly pass between the ependymal cells to enter the cavity of the third ventricle (Herring, Cushing and Goetsch, Karplus and Pecornik). What is more, the secretion appears to be under the control of autonomic fibers that pass from the supra-optic nucleus into the posterior lobe. Hence there is an anatomical basis for the presumption that posterior lobe extract (pituitrin) should have a stimulatory influence on the local vegetative nerve centers. That intraventricular pituitrin would cause a parasympathetic discharge with vagotonic effects, whereas given subcutaneously its action resembles that of adrenalin could not have been foretold.

The interbrain has been shown (Cannon, Bard) to be the seat of primitive emotions which are normally under cortical control but in experimentally decorticated animals, probably from release of the sympathetic nucleus in the posterior hypothalamus, there occur explosions of sham rage accompanied by a mass-discharge of the sympathico-adrenal system.

The parasympathetic apparatus, in all probability under normal conditions is likewise strongly affected by cortical or psychic (Pavlov) influences. However this may be direct stimulation of the tuber or of its descending fiber tracts, or what theoretically amounts to the same thing, a functional release of the

vagus from paralysis of the antagonistic sympathetic fibers, leads to hypersecretion, hyperchlorhydria, hypermotility and hypertonicity especially marked in the pyloric segment. By the spasmodic contractions of the musculature, possibly supplemented by accompanying local spasms of the terminal blood vessels, small areas of ischæmia or hæmorrhagic infarction are produced, leaving the overlying mucosa exposed to the digestive effects of its own hyperacid juices.

Thus it is possible to reconcile the neurogenic theory of ulcerations sponsored by Rokitsky and Virchow's variously modified theory of a primary local cause, whether the lesions are considered in terms of simple erosions, of acute perforations, of autodigestive softening, or of chronic ulcers and whether they chiefly involve œsophagus, stomach, or duodenum.

Those favorably disposed toward the neurogenic conception of ulcer have in process of time gradually shifted the burden of responsibility from the peripheral vagus to its center in the medulla, to the midbrain, and now to the interbrain, newly recognized as a highly important, long overlooked station for vegetative impulses easily affected by psychic influences. So it may easily be that highly-strung persons, who incline to the form of nervous instability classified as parasympathetic (vagotonic), through emotion or repressed emotion, incidental to continued worry and anxiety and heavy responsibility, combined with other factors such as irregular meals and excessive use of tobacco, are particularly prone to have chronic digestive disturbances with hyperacidity often leading to ulcer—effects wholly comparable to those acutely produced by irritative lesions experimentally made anywhere in the course of the parasympathetic system from tuberal center to its vagal terminals.

While this conception of the etiology of ulcer does not account for all ulcerative processes under all conditions it offers a reasonable explanation of the majority of them and is in accord with the personal experience of most victims of chronic recurring ulcer. This briefly, is as near as one can come, with the data at hand, to an inter-

pretation of the neurogenic origin of peptic ulcer and an explanation of its existing prevalence.

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GEOGRAPHIC PATHOLOGY OF GOITER

C ALEXANDER HELLWIG, M D , WICHITA, KANSAS

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NO modern American treatise on thyroid diseases refers to the variations in form and function of goiter, according to the part of the country in which it occurs. From this fact inferences could be drawn that the morphology and physiology of the North American goiter is rather uniform, although our knowledge about this important subject is very rudimentary.

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mitted by many writers that there is, in the recent goiter literature, a bewildering confusion which hinges largely on words rather than on essential facts, but their attempt to remedy it seems to be directed only to the introduction of new terms, thereby increasing the confusion. The general acceptance of an international classification would eliminate confusion, allow a comparison of the various structures of goiter in the different areas of this country, and also facilitate the correlation of the North American goiter with that of other continents. The goiter problem is world wide, but not the same in the different regions, and there cannot be any doubt that the comparative study of the morphology and physiology of goiter not only will be of academic interest, but will open new fields for the practical questions of prophylaxis and treatment.

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Fig. 1. Congenital diffuse goiter (South German type)

rounding thyroid tissue proper and eventually produce an atrophy by pressure of the neighboring lobules (Fig. 14). By this process they form a more or less distinct capsule which delimits them clearly from the normal thyroid pattern. Furthermore there is in the nodules from the beginning a complete absence of division in lobules which interferes with nutrition and resorption of the secretion. The lack of a regular drainage system and blood supply accounts for the degenerative processes so commonly found in nodules after they have reached a certain size, and which were erroneously described by the old writers as special



Fig. 2. Diffuse parenchymatous (microfollicular) goiter South Germany 9-year-old boy

varieties fibrous, hemorrhagic cystic, calcified osseous goiter. It is obvious that the degeneration of the nodules will interfere with the activity of the thyroid gland and from the physiological point of view a clear distinction between diffuse and nodular goiter types appears all the more important.

For the evaluation of the severity of a given goiter endemic, the ratio of diffuse to nodular goiters gives valuable information. It is generally accepted that in a highly goitrous population the nodose goiters outnumber by far the diffuse forms. In de Quervain's clinic, for instance, which draws its material from the center of the Swiss goiter belt, Woelfl found 93 per cent nodular goiters, but only 7 per cent diffuse enlargements of the thyroid. In Dueseldorf, which is located in the lower Rhine valley, the frequency of diffuse goiters increases to 32 per cent and on the German sea shore in Rostock, Hueck found an incidence of 68 per cent diffuse and 32 per cent nodular forms. In Holland there is about an equal distribution of the two different forms, the ratio of diffuse to nodular goiter being 47 to 53 (Josselin de Jong).

Not enough statistics are available in this country to compare the European figures with the conditions in North America. In Kansas, however, which forms the geographic center of the United States, I found among the

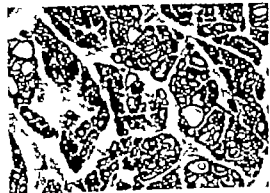


Fig. 3. Diffuse parenchymatous (microfollicular) goiter South Germany 9-year-old girl

TABLE I—MOST COMMON CLASSIFICATION OF GOITER

A Kocher (1919)	Hellwig (1920)	Aschoff (1924)	Wegelin (1926)	McCarrison (1927)	Marine (1927)	Hertzler (1929)	Ruenhoff (1929)	MacCarty (1931)
<i>A Struma diffusa</i>	<i>A Hyperplasia of the thyroid</i>	<i>A Diffuse goiter</i>	<i>A Diffuse hyperplasia</i>					<i>A Thyroid shaped</i>
Struma congenita parenchymatosa	Congenital simple hyperplasia	Congenital diffuse goiter	Struma congenita neonati	Congenital goiter	Simple congenital goiter			
Struma hyperplastica follicularis	Microfollicular Hyperplasia	Diffuse parenchymatous (microfollicular) goiter	Struma diffusa parenchymatosa (microfollicularis)	Parenchymatous goiter	Hyperplasia and hypertrophy			
Struma diffusa colloidales	Macrofollicular Hyperplasia	Diffuse colloid (macrofollicular) goiter a non proliferant b proliferant	Struma diffusa macrofollicularis a resting stage b proliferant	Diffuse colloid goiter	Involution (colloid goiter)	Uniform stage of colloid goiter	Simple colloid goiter	Hypertrophic colloid goiter
Struma diffusa parenchymatosa papillaris	Exophthalmic goiter	Exophthalmic goiter	Struma diffusa basedowiana	Hyperplastic goiter	Exophthalmic goiter	Exophthalmic goiter	Hypertrophy and hyperplasia of the thyroid	Hypertrophic parenchymatous goiter
<i>B Struma diffusa et nodosa</i>		<i>B Nodular hyperplasia</i>	<i>B Nodular hyperplasia</i>					
<i>C Struma nodosa</i>	<i>Adenomata of thyroid gland</i>	<i>C Nodular goiter</i>	<i>C Adenomata of the thyroid</i>					<i>B Nodular goiter</i>
Struma nodosa parenchymatosa	Microfollicular Adenoma	Nodular parenchymatous (microfollicular) goiter	Parenchymatous adenomata (trabecular tubular microfollicular)	Adenoma	Nodular hyperplastic stage	Mixed tumor (fetal adenoma)	True benign parenchymatous neoplasm of the thyroid	Adenomatous goiter with out parenchymatous hypertrophy
Struma nodosa colloidales	Macrofollicular Adenoma	Nodular colloid (macrofollicular) goiter a non proliferant b proliferant	Colloid adenomata a simple macrofollicular b papillary macrofollicular	Colloid adenoma	Nodular involutionary (colloid) stage	Bosselated stage of colloid goiter	Nodular colloid goiter	
Struma nodosa basedowifata	Adenoma basedowifatum	Nodular goiter with extensive epithelial proliferation	Adenoma basedowifatum		Nodular goiter with hyperplasia	Chronic toxic stage of bosselated colloid goiter (toxic adenoma)	Nodular colloid goiter with hypertrophy and hyperplasia	Adenomatous goiter with parenchymatous hypertrophy

goiters of the Hertzler clinic 53 per cent diffuse and 47 per cent nodular forms. Harms states that of the surgical goiter material in Madison (Wisconsin), 57 per cent are of the diffuse and 43 of the nodular type. Wisconsin and Kansas have, therefore, an almost identical distribution of the two forms of goiter and, as we will see later, the microscopic structure and the physiology of goiter also conform very well in these two geographic areas which are about 600 miles apart.

A somewhat higher percentage of nodular goiter is observed in the surgical material of the Mayo Clinic. Boothby states that in 1924 there were 59 per cent nodular goiters and MacCarty (1931) found nodose forms in 67 per cent of 32,000 goiters. These figures

correspond to the low percentage of diffuse goiter in Ann Arbor (Michigan) where Collier encountered only 29.2 per cent diffuse goiters as compared with 70.8 per cent of the nodular form. The incidence of nodular goiter in Michigan is therefore almost as high as at the periphery of the severe Swiss endemic, in Aschoff's institute at Freiburg, near the Swiss border, I found 23 per cent diffuse and 77 per cent nodular goiters. Nowhere however, in North America, does there seem to exist as low a percentage of diffuse goiter as in the mountainous regions of Switzerland (7 per cent), and already from this criterion alone it is obvious that the North American goiter represents an entirely different type of thyroid enlargement, from that seen in Switzerland,



Fig. 4. Diffuse colloid (macrofollicular) goiter

in the Himalaya mountains, and in other severe endemic areas.

THE PARENCHYMATOUS (MICROFOLLICULAR) AND COLLOID (MACROFOLLICULAR) TYPES OF GOITER

Aschoff divides the diffuse and nodular goiters into the parenchymatous or microfollicular and the colloid or macrofollicular types. The first is characterized by a very small size of the acini which are lined with cuboid epithellum and their lumina are filled with only scanty amounts of colloid or appear entirely empty. The macrofollicular or colloid goiter type on the other hand has large often irregular acini and the colloid is abundant. In mountainous regions with a high incidence of goiter the diffuse microfollicular parenchymatous goiters (Figs. 1 and 2) are very common in children and at puberty they are therefore termed "adolescent goiters" by Gold and Orator. In level regions, however they are so rare that most of the American classifications do not even list them. I have never encoun-

tered them in my surgical or autopsy material drawn from Kansas and also Jaffé who examined the thyroid glands of 1,000 autopsy cases at Cook County Hospital, does not mention this type. In areas of high endemicity also the diffuse parenchymatous goiter (Fig. 3) is rarely seen after the second decade of life and is replaced by the nodular microfollicular parenchymatous goiter the so called fetal adenoma (Figs. 17 and 18), which type is really the prototype of mountainous goiter in Switzerland in the Himalayas, and Pyrenees. In 76 per cent of the surgical material at Bern (Switzerland) parenchymatous nodular goiter was found by Woelz and Wydler states that 94 of his 104 cretin goiters showed this type of structure. The reverse incidence is seen in level regions with only slight frequency of goiter. In the lower Rhine valley Orator found only 11.3 per cent of the resected goiters belonging to the microfollicular type and among the surgical material at Wichita (Kansas) 13.9 per cent of the goiters are parenchymatous. This is still higher than in other areas of the United States. In Wisconsin only 8.3 per cent of the removed goiters were of microfollicular structure and in Ann Arbor still fewer namely 6.8 per cent (Coller). The parenchymatous, nodular goiter is so rare in North America that Hertler wants to separate it from the common goiter and proposes



Fig. 5. Non-proliferant diffuse colloid (macrofollicular) goiter

for it the term "mixed tumor" He regards it as "true neoplasm and not as goiter" This standpoint is limited to the goiter forms as seen usually in level countries and is not justified from a world wide point of view of geographic pathology, because the so called fetal adenoma constitutes actually the most frequent type of endemic goiter seen in regions with high endemicity

The diffuse and nodular colloid goiter is subdivided by Aschoff into two forms the non-proliferant (Fig 5) and the proliferant (Fig 7) These are not separate entities, but the transitional stages which one observes between them, suggest that both are only different grades of the same functional stage of the thyroid Also in the non-proliferative form of colloid goiter there are here and there buds of epithelial proliferation in the individual follicles with cubical or almost columnar epithelium and new formation of small daughter acini (Fig 6) In the proliferant form of colloid goiter these cushion-like proliferations are only more extensive and much more frequent On account of this epithelial activity, we regard the colloid goiter not as a result of involution and retention of the thyroid secretion, as many still believe, but as a hyperplastic and hypersecretory process Also the nodular colloid goiter in its earliest

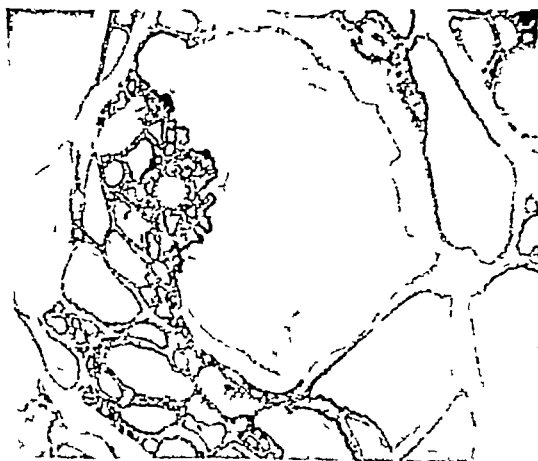


Fig 6 Non proliferant diffuse colloid (macrofollicular) goiter. Cushion like proliferation in acinar wall indicates that the colloid goiter is not the result of retention of colloid only

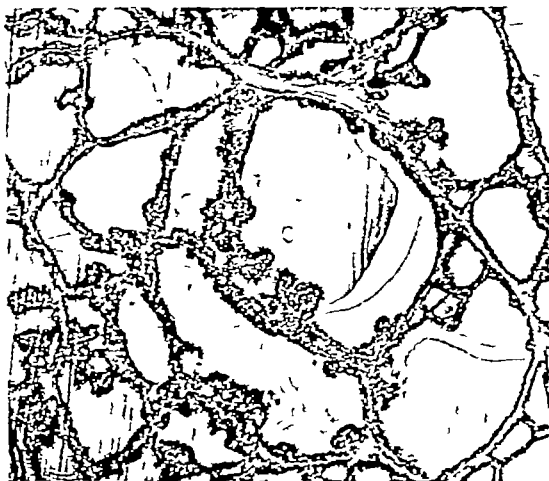


Fig 7 Proliferant, diffuse colloid (macrofollicular) goiter. Marked epithelial proliferation of the acinar wall.

stages very often shows epithelial proliferation, a fact which is not in favor of Rienhoff's assumption that the colloid nodules are merely *involutionary bodies of a hyperplastic thyroid gland* Figure 15 shows the epithelial wall of the large acini in the colloid nodule in a state of proliferation, the cells being much higher than those of the acini of the surrounding thyroid tissue proper

In level countries, the physiological enlargement of the thyroid gland during puberty and pregnancy—periods of physiologic hyperthyroidism—is anatomically a diffuse macrofollicular colloid type of hyperplasia After the twenty-fifth year, the diffuse colloid goiter, especially the proliferating form, is very often (in 70 per cent of my own cases) accompanied by symptoms of hyperthyroidism There is furthermore a close, histological relationship noticeable between the proliferant diffuse colloid goiter and the exophthalmic goiter (Figs 9 and 10) From the diffuse colloid goiter, transition stages with higher and higher proliferation of the acinar wall lead finally to the classical microscopic picture of exophthalmic goiter Marne and Lenhart attempted to differentiate primary and secondary exophthalmic goiter, the former originating in a normal, the latter in a goitrous gland The expediency of this division seems questionable From my own studies, not only of North American goiters but also of many glands



Fig. 4. Diffuse colloid (macrofollicular) goiter

in the Himalaya mountains, and in other severe endemic areas.

THE PARENCHYMATOUS (MICROFOLLICULAR) AND COLLOID (MACROFOLLICULAR) TYPES OF GOITER

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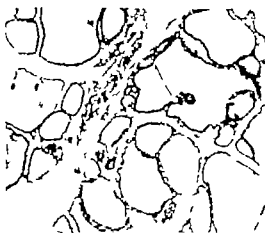


Fig. 5. Non-proliferant diffuse colloid (macrofollicular) goiter.

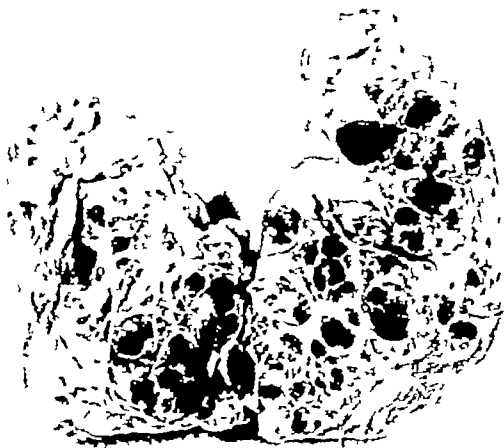


Fig. 11 Nodular hyperplasia Transitional stage between diffuse and nodular goiter

correlate the microscopic picture with the clinical symptoms, we must use great care in drawing conclusions concerning the function of a nodular gland. It seems almost impossible in a specimen with many—sometimes more than a hundred nodules of different structure—to get a correct impression of the histological character of the whole gland by examining sections from only a few different areas. But there is general agreement that the nodular colloid goiter of the level countries also is often accompanied by hyperthyroidism. Among the goiter patients of the Hertzler clinic, 60 per cent of those with non-proliferant, and 85 with



Fig. 13 Non proliferant, nodular colloid (macrofollicular) goiter. The epithelium in the nodule is higher than in the thyroid tissue proper. The latter is compressed.



Fig. 12 Nodular colloid (macrofollicular) goiter. Small size of nodules, very thin capsule, absence of higher grade of degeneration are characteristic of the North American goiter.

proliferant nodular colloid goiter showed definite toxic symptoms. Table III illustrates the high incidence of diffuse and nodular colloid goiters as compared with the macrofollicular structures in level countries, and in Table IV the frequency of thyreotoxicosis is listed according to the different localities.

We learn from these tables that in mountainous regions the nearer one approaches the center of the goiter endemic, the less he meets the colloid goiter. We find there as a prototype of goiter during childhood the diffuse parenchymatous (microfollicular) goiter, while in adults the parenchymatous nodules prevail. Thyreotoxic goiter is an exception in these regions, and we understand that Wegelin, who



Fig. 14. Capsule formation between two colloid nodules. This formation consists of compressed thyroid tissue proper.



Fig. 8. Exophthalmic goiter. Dense, gray areas of epithelial hyperplasia in diffuse colloid goiter.

from European patients I am forced to the belief that exophthalmic goiter develops usually in a diffuse colloid goiter. Many of the exophthalmic goiters I examined presented on the cut surface, either throughout or in patches, an amber red and translucent appearance suggesting a colloid rich tissue (Fig. 8). In nearly 85 per cent of the glands from patients with Graves disease groups of lumina could be distinguished with the unaided eye. These lumina represented large colloid containing follicles such as one never sees in the normal gland, but which are char-

acteristic in the diffuse colloid goiter. Histologically in almost every instance areas with large colloid filled acini were present either with or without proliferation of the acinar wall. That these changes are not due to an involution caused by Plummer's treatment is indicated by the fact that I saw them also in European material and in exophthalmic goiters obtained from Dr. Hertler's clinic which were resected prior to the era of pre-operative lugolization.

Clinical and histological studies indicate, therefore, that diffuse colloid goiter—especially the proliferating form—and exophthalmic goiter are two nearly related stages of thyroid activity and that one of them can easily change into the other. Also epidemiologic statistics are in favor of this opinion, since diffuse colloid goiter is commonly associated in the same locality with Graves disease while there is little statistical evidence in regard to the association of thyrotoxicosis with diffuse or nodular macrofollicular parenchymatous goiter.

The nodular colloid goiter also is often the cause of toxic symptoms, especially if the nodules are very small without distinct fibrous capsule and without higher grades of degeneration such as seems to be the rule with the North American type. While it is usually not difficult in a given case of diffuse goiter to



Fig. 9. Exophthalmic goiter. Acini appear empty. Specimen obtained before era of Plummer's pre-operative treatment with Lugol's solution.



Fig. 10. Exophthalmic goiter, resected after administration of Lugol's solution. The acini are filled with dense colloid. The hyperplasia is still marked.

TABLE II—INCIDENCE OF DIFFUSE AND NODULAR GOITER

Locality	Author	Diffuse Goiter	Nodular Goiter
Bern (Switzerland)	Woelz	7	93
Duesseldorf (Lower Rhine Valley)	Orator	35	65
Rostock (North German Sea Shore)	Hueck	68	32
Utrecht (Holland)	de Jong	47	53
Halstead (Kansas)	Hellwig	53	47
Madison (Wisconsin)	Harms	57	43
Rochester (Minnesota)	Boothby MacCarty	41 32 2	59 67 8
Ann Arbor (Michigan)	Coller	29 2	70 8

taken and the statistical data which are available on the variations of form and function of goiter according to different geographic areas are very meager. From the few facts which are known, it would appear that the North American goiter does not vary in different regions as widely as does the European. There are three outstanding characteristics which distinguish the North American goiter from the types seen in mountainous regions with high endemicity: (1) A relative frequency of diffuse enlargement of the thyroid gland, (2) the absence of congenital microfollicular goiter and the scarcity of microfollicular nodules, the so called fetal adenomas, (3) the high incidence of macrofollicular colloid goiters. The last characteristic is, I believe, closely related to a very marked frequency of Graves' disease and nodular toxic goiter in this country.

In this paper, only data from surgical material were used and they cannot be regarded as conclusive before they are completed by autopsy findings, since only anatomical studies in the postmortem room will embrace all age groups and thereby variable factors, pertinent to surgical material, will be excluded (Jaffé, Orator).

A thorough knowledge of the variations in structure and function of goiter according to the locality will necessarily influence also our conception of the etiology of this world wide disease and will be of benefit in solving practical problems, prophylaxis, and treatment.

The present tendency of goiter students to use their own nomenclature and to introduce

TABLE III—RELATIVE FREQUENCY OF COLLOID, EXOPHTHALMIC AND PARENCHYMATOUS GOITER

Locality	Colloid Goiter	Exophthalmic Goiter	Parenchymatous G
Bern Woelz Wydler	26 3 8 5	3	70 - 91 5
Duesseldorf	73 6	15 1	11 3
Halstead (Kansas)	68 4	16 7	13 9
Madison (Wisconsin)	76	14 7	8 3
Ann Arbor (Michigan)	78 6	10	6 8

TABLE IV—INCIDENCE OF GOITER WITH THYREOTOXICOSIS IN DIFFERENT REGIONS

Locality	Author	Frequency of Thyreotoxicosis Per cent
Bern (Switzerland)	Woelz	3
Duesseldorf	Orator	44
Danzig (Baltic Sea shore)	Liek	50
Stockholm (Sweden)	Troell	57 3
Halstead (Kansas)	Hellwig	65 6
Madison (Wisconsin)	Harms	71 3
Dayton (Ohio)	Simpson	56 1
Ann Arbor (Michigan)	Warthin	42 1
Rochester (Minnesota)	Plummer (1913) Boothby (1924)	68 51 3
Portland (Oregon)	Menne	67 5

new terms with every new publication should be discouraged, since it does not permit a systematic comparison of the various structures of goiter in different geographic areas. For a successful comparative study of goiter the use of a uniform nomenclature seems imperative and Aschoff's classification which, in 1927, at the International Goiter Conference in Bern found the unanimous consent of all leading goiter students should be generally accepted also in this country.

CONCLUSIONS

1 The morphology and physiology of the European goiter varies widely according to the different regions.

2 The few statistical data available for North America seem to indicate that the goiter type in this country is rather uniform, but very different from that in regions of high endemicity (Switzerland, Himalayas, Pyrenees).



Fig. 5. Proliferant, nodular colloid (macrofollicular) goiter. Marked epithelial proliferation in the nodules. No evidence of "involution" (Rienhoff)



Fig. 6. Nodular colloid goiter with marked epithelial proliferation. Adenoma based on literature of the European literature

lives in the center of the Swiss goiter endemic, regards exophthalmic goiter as a special entity of thyroid disease which has no relation to the common endemic goiter. This view however will not hold if one considers the peculiarities of the goiter typical for level countries. Here as in North America, exophthalmic goiter and toxic nodular goiter are very common and they develop apparently on the basis of the most frequent type in these level regions, the macrofollicular colloid goiter. The underlying

cause of Graves' disease and toxic goiter is not a constitutional thymico-lymphatic anomaly as Warthin and Simpson hypothesize, but the diffuse nodular colloid goiter itself is the essential organic factor predisposing to thyrotoxicosis.

COMMENT

A systematic comparative study of the North American goiter has not yet been under-



Fig. 7. Nodule parathyroidism (microfollicular) goiter. Fetal adenoma of the older writers. It is very common in regions with high endemicity. Very rare in level countries.



Fig. 8. Nodular parathyroidism (microfollicular) goiter. The acini in this type are almost solid, sometimes tubular. Hyaline degeneration of the center.

A NEW METHOD FOR GRAPHICALLY RECORDING THE CONTRACTIONS OF THE PARTURIENT HUMAN UTERUS

A STUDY OF THE EFFECT OF CERTAIN SEDATIVES, ANESTHETICS, AND STIMULANTS UPON THE UTERUS IN LABOR¹

SAMUEL MAYER DODEK, M A , M D , CLEVELAND, OHIO

Fellow in Obstetrics School of Medicine Western Reserve University

J. MATTHEWS DUNCAN, lecturer in midwifery in Surgeons' Hall Medical School, Edinburgh, during the middle of the last century was the first it seems of whom there is any record as having attempted to demonstrate experimentally the uterine force exerted in labor. His work consisted essentially in ascertaining the amount of force necessary to rupture fresh fetal membranes by measured water pressure, which he regarded as a fair index to normal or "natural labor." For the extreme pressures he recorded, by a dynamometer, the amount of force necessary to be exerted in forceps extraction, during the uterine contractions. His figures arranged in excellent tabular form fall well within the large range of since variously estimated pressures as from 4 to 400 pounds (Williams). He did not measure the uterine forces directly. Among his writings, however, one discovers that he did realize the possibility of direct measurements and although he seemed somewhat reluctant to try the method which he suggested, he did describe it.

Two years before Duncan's excellent book appeared, Carcassone is said to have presented an instrument for measuring the uterine contractions before the French National Academy of Medicine. He called his instrument the *metro-dynamometre* but no description of it seems to have appeared, nor are there any records of the work done with it.

It remained for Friedrich Schatz, of Germany, in 1872, to perfect a method for obtaining permanent graphic records, by internal hysterography, of the force and nature of the uterine contractions in labor. His work is classic and no investigation or literature pertaining to the physiology or dynamics of the parturient human uterus is complete without full regard for his methods, his results, and his deductions. He used a small rubber bulb

or *Kolpeurynterblase* of from 70 to 80 cubic centimeter capacity which was filled with water and was connected in a closed measured system, by means of a T-tube to a revolving recording drum, and to a calibrated mercury manometer. Preferably under chloroform anesthesia, the bulb was introduced into the uterus, past the presenting part, to the abdominal surface of the fetus, care being rigidly exercised not to rupture the membranes. By this method he was able to get, simultaneously, the force in millimeters of mercury exerted by the contracting uterus upon the rubber ball, as well as a permanent, timed tracing of the contractions and relaxations. His tracings demonstrate the pressures exerted in the several stages of labor, the duration of the increment, acme, and decrement of the contractions, and the influence of the addition of abdominal pressure.

Eight years after Schatz, Poulet, of France, constructed an apparatus which he called the *Tocograph*, with the help of which he hoped to determine not only the forces exerted by the uterus in labor, but also the additional forces contributed by the abdominal muscles. To this end he introduced a rubber bulb or balloon into the uterus and one into the rectum, above the presenting part, each of which was connected by tubing to a recording quick-silver manometer. Floats and writing points were adjusted to the surface of each column of mercury and tracings were made upon Ludwig's kymograph. It does not appear that his results, by these studies, were sufficiently successful to permit convincing conclusions.

Polaillon, a contemporary of Poulet used a small india rubber balloon, but unlike Schatz he placed it just within the cervix and used a Marey tambour for recording. His work seems to have been more reliable than that of Poulet. In order to account for acces-

¹From the Department of Obstetrics and Gynecology and the Department of Pharmacology School of Medicine, Western Reserve University, Cleveland, Ohio. This article is the revision of a thesis presented in partial fulfillment of the requirements for the degree of Master of Arts Department of Obstetrics and Gynecology Graduate School, Western Reserve University June 1931.

3 In Kansas and Wisconsin, there are more diffuse than nodular goiters among surgical patients.

4 Congenital parenchymatous goiter is absent. The diffuse enlargement of the thyroid during puberty and pregnancy represents a diffuse colloid goiter.

5 Parenchymatous nodules of the thyroid gland—the fetal adenomas of the older writers—constitute only 6 to 14 per cent of resected goiters.

6 The most common structure of goiter in North American surgical material is the diffuse and nodular colloid goiter (68 to 79 per cent).

7 Thyreotoxic symptoms, accompanying goiter are more frequent in this country than in any other so far studied (70 per cent of the surgical cases).

8. The North American goiter resembles the goiter forms as found in European level countries (Northern part of Germany Holland Russian lowland).

9. A systematic comparison of the morphology and physiology of goiter in many different areas of North America seems to be of great practical importance and for its success the acceptance of a uniform classification appears essential.

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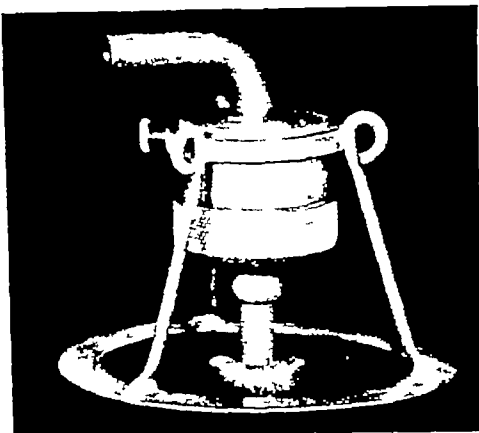


Fig 3 Air chamber and plunger in tripod support

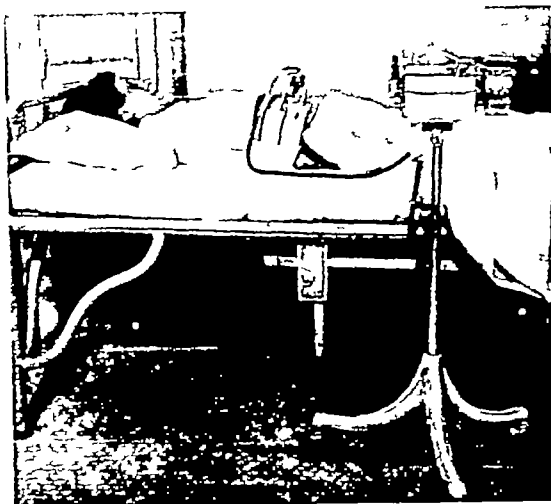


Fig 4 The hystero-graph applied to the abdomen of a patient in labor. The recording apparatus is also set up

It goes without further comment, that it is indispensable for the patient to lie absolutely quietly, since moving from side to side will alter the support given to the weight, that coughing, vomiting, or sneezing may also displace the weight, and that the bed upon which the patient lies may not be moved. It may, of course, be assumed that these ideal circumstances may be found among extremely co-operative patients during and after the third stage of labor, but it is almost impossible to conceive that one could ever get a sufficient number of patients during the first and second stages of labor who would be ideal subjects, to allow that the apparatus has any value as a routine method to record the contractions of parturition.

Aleck Bourne and J. H. Burn are the most recent contributors to the graphic study of the action of the parturient human uterus. Most of their work deals with the action and dosage of pituitary extract and the ergot alkaloids on the uterus in labor. Their efforts, in 1927, toward the standardization of the unit dose of pituitary extracts were a decided contribution to the best obstetrical literature. In July, 1930, their most recent article appeared in which they used their original method of a water filled system consisting essentially of a rubber intra-uterine bag and stem, and a drum recording apparatus to determine the action upon the human uterus, of several commonly used drugs and anesthetics.

In the United States, M. Pierce Rucker, of Richmond, has perhaps contributed more than anyone else to the graphic study of the human uterus in labor. His most inclusive reports embrace the influence of various anesthetics and analgesics on the contractions of the uterus, the action of pituitary extract and thymophysin, and the effect of ergot. He took the opportunity, whenever he had occasion to insert the hydrostatic bag (Voorhees bag) into the cervix of one of his patients, to connect the stem of the bag with a mercury manometer by means of a thick wall rubber tube. The free arm of the manometer was fitted with a float that carried a writing point and inscribed its movements on a revolving smoked drum.

A NEW METHOD FOR EXTERNAL HYSTEROGRAPHY

When the investigation with which this paper is concerned was first considered, it was believed that if any satisfactory method could be found whereby tracings of the uterine contractions might be recorded without subjecting patients to unnecessary intra-uterine manipulations, it would be easily possible to collect sufficient data in a relatively short time with very little if any hardship to subjects or inconvenience to nursing assistants. It was realized, especially, that every patient,



Fig. 1. A composite picture showing the uterus before and during a contraction. (De Lee. Courtesy W. R. Saunders.)

sory uterine movements, he divided them into extrinsic and intrinsic, the latter being the irregular fetal movements and the former made up of such extra-uterine activities as coughing, sneezing, deep sobbing, transmitted maternal arterial pulsations, bearing down efforts, and movements of parts of the maternal skeleton as might cause additional abdominal pressure.

In 1891 Acconci, an Italian using an apparatus similar to Polakillon's, made several determinations of the action of various agents on uterine contractions and Doehnhof a German in 1892 demonstrated also graphically that chloroform had a definite depressant action upon contractions of the uterus in labor in direct proportion to the depth to which that anesthetic was administered.

F. Westermarck (1893) seems to have been the first investigator who objected to the methods used by some of his predecessors and contemporaries in the field of study under review. He argued that to introduce a rubber bulb or balloon of a large capacity (70 to 80 cubic centimeters) into the uterus, gave rise to the dangers of intra-uterine manipulations that it caused increased uterine contractions above the normal due to the bulk added to the contents of the uterus, and that it was necessary to anesthetize each patient in order successfully and satisfactorily to introduce the bulb into its proper position in relation to the fetus and membranes.

To overcome these pertinent objections, Westermarck used a small rubber bulb similar



Fig. 2. Pneumatic chamber B unscrewed from plunger sheath, A, to demonstrate plunger "X" and rubber diaphragm. The outlet tube, Z, is connected to the writing system by rubber tubing "X" at.

to the nipple of a child's nursing bottle, of a capacity of 2 cubic centimeters, which he attached to a urethral catheter. Using this apparatus and a drum recording mechanism, he made many very satisfactory and exhaustive observations upon the duration of labor, the various phases of labor and labor pains, as well as the height to which the uterine forces rose in millimeters of mercury during the acme of each pain.

A departure from all of the procedures mentioned to record uterine contractions was first taken by Ruebeman of the Frauen Klinik, Dresden, in 1913 during his studies of the action of pituitary extracts especially in the third stage of labor but no description of his method was published until 7 years later. In 1920 he included, in a report concerning the clinical and experimental action of quinine hydrastis, and croctamin, a method called external hysterography which demonstrates an anxious desire to get away from unnecessary experimental intra uterine manipulations. The method is no doubt of value for studies conducted postpartum, but its many shortcomings for use in observations conducted during the first and second stages of labor are at once apparent.

The apparatus is essentially a device of known weight which is carefully adjusted and supported on a frame by a cord and pulley so that it rests on the abdomen covering the uterus. Apparently when the uterus contracts, the weight is lifted, and by means of the cord the evenly balanced writing arm of a timed revolving recording drum, to which it is attached, is raised and a tracing is made.

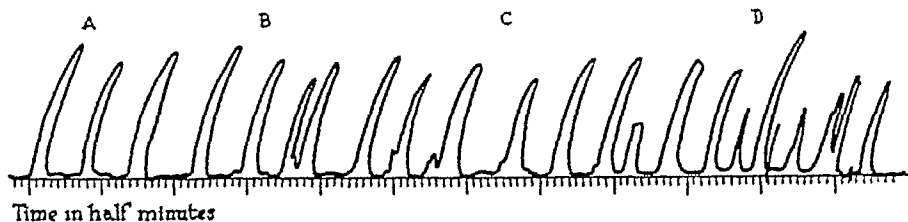


Fig 7* Normal first stage tracings in primipara showing double contractions and fetal movements, left occipitoposterior position, three fingers' dilatation 4. No analgesia or anæsthesia, B, contractions painful, patient comfortable between pains, C, patient more uncomfortable between pains and complaining during contraction, D, patient very uncomfortable and complaining

*The tracings shown in Figures 7 to 25 have been redrawn to produce better printing plates. Photographs of the original tracings appeared in the thesis.

air which in turn affects a sensitive rubber tambour supporting a writing point

Figure 2 illustrates the plunger section of the apparatus and the air-chamber, which have been unscrewed from one another to allow one to see the way in which the rubber dam is attached and to make more vivid the relationship which the internal end of the plunger bears to the diaphragm when inward pressure is made against the external end. The metal outlet tube, *z*, allows the air, compressed in the chamber, to be transmitted to the recording system. These parts of the apparatus are screwed tightly together, and supported on the abdomen in a tripod-like structure, which is fixed by tapes tied in the eyelets of the tripod and held fast by adhesive straps to the patient's loins (Figs 3 and 4)

The apparatus is applied to the abdomen over the point of maximum contraction and bulging which most frequently is in the immediate neighborhood of the umbilicus, and by increasing or decreasing the tension on the tapes, as well as by lowering or raising the apparatus in the support by means of the set screw the plunger is set approximately half its length within its sheath. The metal outlet tube is then connected by rubber tubing to the writing tambour (Fig 5). A glass Y-tube is placed in this circuit so that the free arm may be opened during the manipulations of adjustment, thus relieving any adventitious compression of the air, from handling or squeezing the tubes, before the study is begun. Before each study, the entire air system is immersed in water to detect air leaks which are repaired at once

Abdominal respiratory movements and fluctuations of the abdominal wall due to pulsations transmitted from the maternal aorta, do not affect the plunger. The entire apparatus with its tripod support rests on the evenly undulating movements of the abdomen in the intervals between contractions similar to the way in which a moored skiff rests upon the ripples of a calm lake. Violent contractions of the abdominal muscles, voluntary or involuntary, or increase in the intra-abdominal pressure due to hard coughing, vomiting, or bearing down efforts cause additional compression of the column of air in the system and superimposed lines on the corresponding tracings. Fetal small parts, when they move directly under or very nearly adjacent to the plunger, also cause a very transitory variation in the tracings

The sensitive tambour, upon which is supported a writing arm with a small glass pen, is part of the recording apparatus (Fig 6) modified by Mr Dann from a similar apparatus manufactured by the Toledo Technical Appliance Company, Toledo, Ohio, which was designed by him, and Doctor Harry R

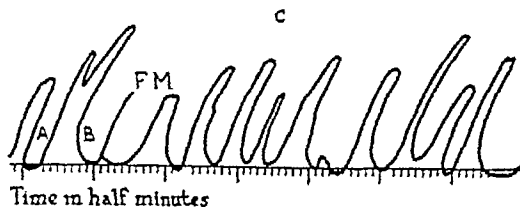


Fig 8 Normal first stage contractions of a primipara, no analgesia, no analgesia. Points A and B indicate where pain was felt and where it disappeared, respectively. Note the irregular intensities, double contractions, and fetal movements, FM. C, Cervix dilated 3 fingers

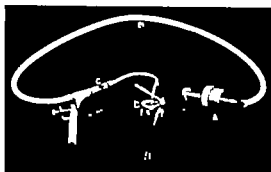


Fig. 5. The pneumatic chamber and plunger, 4, are connected by rubber tubing to the sensitive tambour *D* upon which is mounted the writing arm and ink point, *F*. The glass Y tube, *C*, allows for a free arm which may be released during adjustments.

were she to have a hydrostatic bag inserted for purposes of study would consequently be subjected to at least one additional period of anesthesia and that she would be jeopardized by the hazards of vaginal examination and cervical manipulations, relatively insignificant as they may be in a well conducted maternity surgery. This last method of study if it were to be done on a large enough scale to be of any value would require the frequent services of assistants to prepare the patient, sterilize and prepare the colpeurynter set up anæsthetize the patient and assist with the attachment of the recording apparatus to the stem of the bag. Valuable opportunities might be lost too to study a certain patient at a certain time, if at that time delivery activities were so great—as very frequently occurs—as not to be able to have available a delivery room team.

From the viewpoint of study it was felt that the presence of a hydrostatic bag in the uterus or cervix, causing as it nearly always does, added stimulation to the force and frequency of labor contractions, would not give a fair estimation of the uninfluenced uterus and that it would be impossible to study the normal effect of drugs which are said to stimulate the induction of labor and the intensity of established contractions.

It was realized too that an apparatus to be successfully used in routine external hysterography must be so constructed as to be insensitive to normal breathing, pulsations

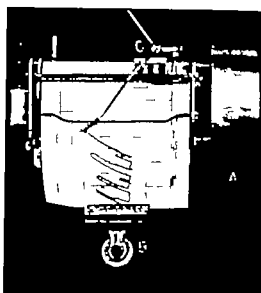


Fig. 6. The writing arm and ink point mounted on the recording apparatus with the tambour, *C*. The ruled paper controlled by the clock, *A*, and weight, *B*, mechanism moves at the rate of 1 inch every 5 seconds, each small square being equivalent to one half minute.

transmitted from the abdominal aorta, and ordinary movements of the patient. It should also be light in weight, not cumbersome or annoying to the subject, and easily placed and fixed in position on the abdomen during any stage of labor without interfering with, or retarding the course of progress.

Such an apparatus was constructed first of brass and then of aluminum from suggestions made by Professor Sollmann, and with the assistance of Mr. Morris Dann, of the Department of Pharmacology of the Western Reserve University Medical School. I have used it exclusively with complete success and satisfaction for the accumulation of all the data presented in this report. The principle upon which it is based is that during each uterine contraction the anteroposterior diameters of the uterus and the maternal abdomen are increased—the more severe the contraction the greater the increase (see Fig. 1). Advantage has been taken of these phenomena by fixing the plunger and diaphragm of a closed air system to the abdomen, so that each contraction causes a compression of the

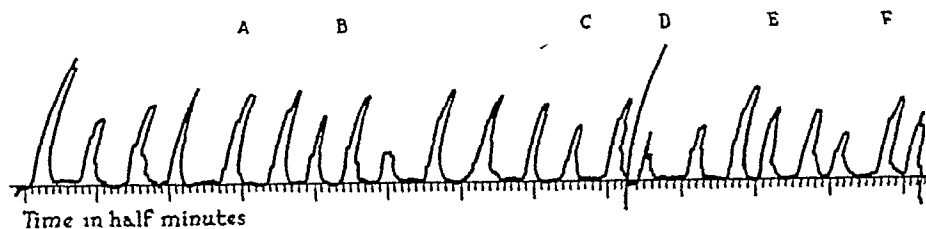


Fig 12 Ether as an analgesic has no effect upon the progress of labor when given during contractions A, Inhalation of approximately 1 dram of ether during each pain, B, patient is more comfortable during pains, C, membranes intact, nearly fully dilated cervix, D, vomiting, E, patient comfortable during pains, ether continued, F, cervix fully dilated, delivered shortly thereafter

except in pathological changes of its contour or cells, and in labor Ko Chi Sun, in his work on the spontaneous contractions of the human uterus, at Johns Hopkins University, was able to demonstrate these facts beautifully in subjects ranging from a 6 months fetus to women of the climacteric

The painless intermittent contractions which also persist all through pregnancy become painful and increase in intensity of force and frequency of recurrence during the progress of labor The contractions, as a rule, are at the onset not very fierce and recur at intervals of from 15 to 20 minutes As labor progresses, the contractions grow stronger and more frequent, and whereas at first the patient may have experienced some discomfort and feeling of fullness in her lower back, she now begins to complain of pain and may beg for relief

When labor is well established the uterus contracts at intervals of from 1½ minutes to 4 minutes Each contraction reaches its maximum slowly, but the acme is maintained only a relatively short period of time before relaxation sets in The whole time which

transpires from the beginning of a contraction to the point of complete relaxation varies in different patients and at different times during a single labor Contractions also may be double, that is, somewhere before a contraction has reached a point of complete relaxation the uterus may contract again, the second contraction sometimes being more painful and intense than the original Contractions, too, are not all of the same degree of intensity, especially in the first stage of labor A strong and very painful contraction may be followed by a mild and weak one, or, one or two weak pains may precede a very firm and painful one The periods of lessened work and the phases of complete relaxation and rest between contractions are no doubt useful for the carrying off of the waste products of muscular activity by the circulatory system, and for supplying the fetus with sustaining oxygen and the uterine tissues with fresh oxygenated blood in preparation for the exertion

Figure 7 is the reproduction of a tracing made by the contraction of the uterus of a primiparous patient, who had had no agents

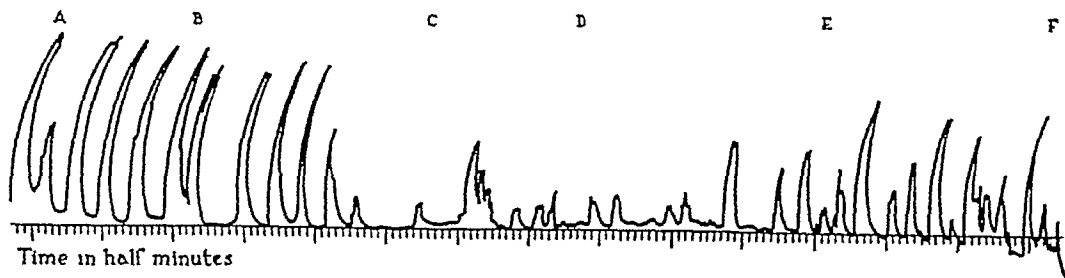


Fig 13 Tracings of a typical low forceps delivery, ether anesthesia, primipara A, Cervix fully dilated, B, head on perineum, C, ether on, to control contractions, D, scrub, E, delivery begun—left occiput anterior presentation, low forceps, no ether for contractions, F, birth

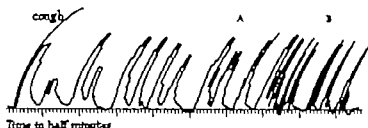


Fig. 9. Transition from first to second stage. Note the superimposed tracings caused by increased pressure or bearing down at A. Patient was a primipara; vertex presentation; no anesthesia or analgesia.

Trattner of the Department of Genito-urinary Surgery Cleveland City Hospital to record the contractions of the human ureters and the rate of urine flow. The ink point inscribes its tracings upon a continuous roll of white metrolator paper which is ruled in tenths of inches. The unrolling of the paper is accomplished by a revolving cylinder at the ends of which are evenly spaced, spiked cogs which fit into the holes on the edges of the paper. The cylinder is made to rotate by means of a clock and weight mechanism so that one inch of the paper passes a given point in 5 minutes, each tenth of an inch ruling therefore representing one half of each minute.

It is possible with this specially ruled paper easily and readily to read off the time factors in any particular study such as the intervals between contractions, the duration of time from beginning to end of each contraction, the time necessary for any particular drug or agent to affect the tracings, and so forth.

No concern has been given to measuring uterine forces by the mercurial manometer.

None of the patients complained of any great discomfort due to the weight or presence

of the apparatus, and they often manifested considerable interest in watching the 'pictures of their pains,' or learned to prepare themselves for a pain when they saw the writing point begin to rise from the base line of relaxation during the short interval before a contraction was sufficiently intense to arouse central registration of pain.

Nearly fifty individual studies were completed at the time of this writing. Tracings were made in the first and second stages of labor under varying circumstances, and the clearest specimens of each class photographed for reproduction in this report.

CHARACTERISTIC TRACINGS

The Uninfluenced or Control Uterus in Labor

The human uterus, just as all other non-striated muscular organs, is independent of the will of the patient and its contractions can not, therefore be diminished or increased by her volition. The uterus contracts painlessly throughout the greatest span of life of the human female and even in intra-uterine life—



Fig. 10. Typical second stage tracing when no analgesia or anesthesia has been given. Patient was primipara and the cervix was fully dilated. A Voluntary bearing down.



Fig. 11. Effect of ether on the uterine contractions of a multipara, vertex presentation, in labor. Point A indicates the beginning of the second stage of labor and the arrow indicates the commencement of drop ether.

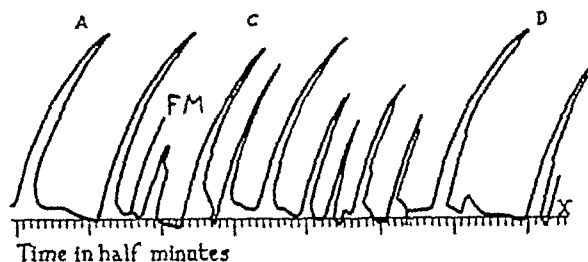


Fig 15 Note the severe and strong contractions recorded before the administration of spinal anesthesia. Patient was a primipara, left occiput posterior presentation, cervix 9 centimeters dilated. A, Contractions severe, FM, fetal movements, C, patient complains bitterly. D, 2 cubic centimeters spinoanesthetics were injected between fourth and fifth lumbar vertebrae at x.

duration of a single contraction while the uterus remains firm.

Graphically the transition which occurs from the first stage to the second is most vivid. From the even and smooth curves seen nearly always in the first stage, the tracings reveal lines superimposed upon the basic curve of the contractions in second stage labor. These accessory lines are due to the several expulsive efforts of the patient which increase the intra-abdominal pressure.

Figure 9 very clearly shows this transition at the time of complete effacement and dilatation of the cervix. The case represented is that of a primiparous patient, who had not been given any analgesia or anesthesia so that an uninfluenced record might be made. At point B on the tracing the curves begin to take on the few accessory superimposed tracings of early second stage labor, and from 7 minutes after that point all of the subsequent contractions are accompanied by "bearing

down" efforts. Due to the fact that the graph paper moves slowly (at a rate of 1 inch every 5 minutes) the semi-voluntary expulsive and "bearing down" tracings come very close together, and individual lines may be obscured by the proximity.

With my method of recording the tracings described above are typical of the second stage when no anesthetic has been administered, and Figure 10 demonstrates a 25 minute period following complete dilatation of the cervix in a primiparous patient.

A Classification of the Agents Studied

The medicaments and agents generally used during the first and second stages of labor can, broadly speaking, be divided into two main groups: (1) those which are used to relieve suffering and mental anguish so that labor may be bearable during its entire course, and (2) those which are used to stimulate the progress of labor so that the period of time during which a patient must suffer will be shortened. The first are given primarily

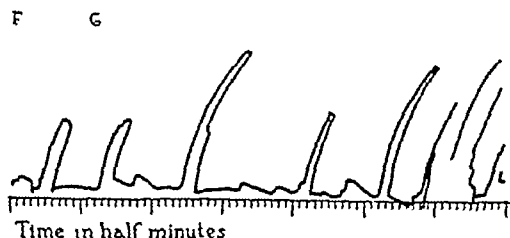


Fig 15A The immediate effect of spinal anesthesia. Depression of frequency and intensity, increased tonic. The base line is higher than in Figure 15. F, Immediately after completion of intraspinal injection, G, patient feels no pain during uterine contractions, and is completely anesthetized caudal to the costal margin.

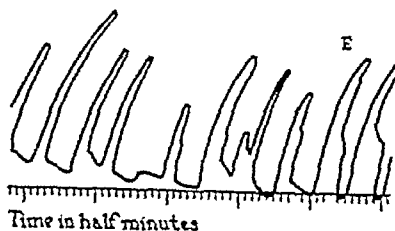


Fig 15B Anesthesia persists but contractions recur. Tonicity of uterus approaching complete relaxation between contractions near the end of the tracing. E, Anesthesia persists and continued in all for 1 1/2 hours.

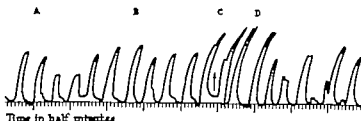


Fig. 14. The effect of nitrous-oxide-oxygen analgesia. Primipara, cervix dilated two and one half fingers. A, No inhalation analgesia, B contractions painful, C nitrous-oxide analgesia, D patient comfortable.

for the relief of pain. The cervix at the time this study was made was dilated 7 centimeters and the fetus was presenting in the left occipitoposterior position. One can observe that the intervals between the several contractions vary from $\frac{1}{2}$ minute to 3 minutes that there is a variation in the degree of intensity between certain of the several contractions, that two and possibly three double contractions occurred and that the duration of time from the beginning of the increment to the end of the decrement varies in different contractions from less than 1 minute to nearly 3. It is also remarkable that although the contractions may reach their maximum slowly they do not always do so gradually an occasional one seems to maintain itself at a certain level for a short period of time, and then suddenly increases in intensity. The impression made by the movement of a fetal small part is also apparent in this exhibit (the quick contraction fifth from the right)

The contractions of the uterus in labor are not painful throughout the entire phase. For a very short time after the contraction begins there is no sensation of pain and shortly before complete relaxation has been reached

pain disappears. Pain becomes progressively more severe from its onset and is maintained at its peak during the entire acme of the contraction, leaving gradually as the uterus relaxes. The letters A and B in Figure 8 indicate, respectively the points on the tracing where pain was first experienced and where it entirely disappeared. These were analogous for all of the contractions shown. This particular tracing also demonstrates, in contrast to the one discussed in the preceding paragraph, the longer periods of time which may be consumed from the beginning to the end of contractions. Here the periods extend from 1 minute to 3 minutes, while the intervals range from less than a minute to over 3. The individual variations in the intensity of the contractions, too, as well as fetal movements and a "double pain" are evident here.

The uterine forces in the first stage of normal unobstructed labor perform among others, two main functions: the dilatation and effacement of the cervix. During this period the patient herself plays a more or less passive rôle in that she is unable to help the course of labor to any great extent. When the cervix is fully obliterated and opened, however the pains take on an expulsive character. The patient becomes aware of a body in her pelvis—the presenting part of the fetus—and she experiences a desire to expel it. Then, with the onset of each pain, she fixes her diaphragm and chest in inspiration, closes the glottis, and by a powerful and rigid action of the abdominal muscles "bears down" or strives to drive the presenting part to a lower plane in the pelvis, or onto the perineum. The patient often makes several expulsive efforts, similar to the one described, throughout the

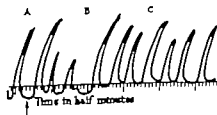


Fig. 14 A. A Nitrous-oxide, surgical depth, begins, B patient completely anesthetized; C, note increased toxicity

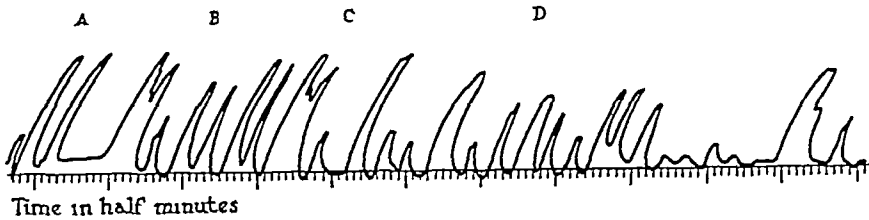


Fig 17 Tracings showing the immediate effect of morphine scopolamine upon the uterine contractions in a primiparous patient. A, First stage, two fingers' dilatation, no analgesia or anæsthesia, B, patient complaining and very restless, C, $\frac{1}{6}$ grain morphine, $\frac{1}{100}$ grain scopolamine, D, sleeping, no complaints during contractions

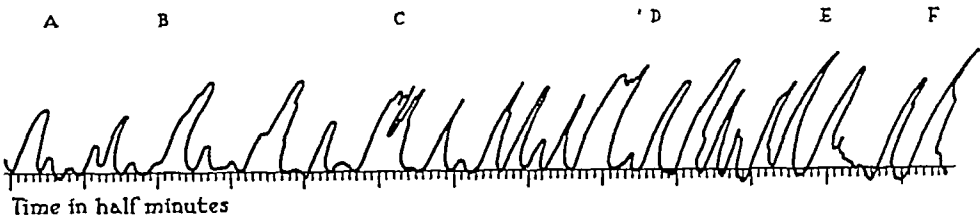


Fig 17A Tracings showing the effect of two subsequent injections of scopolamine in the same patient as in Figure 17. A, Injection of $\frac{1}{100}$ grain scopolamine, B, patient groaning during contractions, sleeping well between pains, C, restless during pains, restful between pains, D, scopolamine injection of $\frac{1}{400}$ grain, E, very restless during pains, sleeps between contractions, F, rectal ether given

In Group I are found that invaluable class of agents—the anæsthetics and analgesics—which when skillfully used, and wisely, can be made to transform what is too often a horribly painful, exhausting, and tortuous ordeal into nothing more than a vague memory of an uncomfortable experience. At the Cleveland Maternity Hospital, certain anæsthetics and analgesics, after a long period of clinical observation, have come to be used more or less routinely, and for the purpose of confirming or altering the clinical impressions which have been gained as well as for the purpose of studying the action of several less extensively used, and consequently less familiar preparations, this investigation has primarily been undertaken

The Influence of the Agents Upon the Uterus in Labor

Ether Sir James Y Simpson was the first to use ether in obstetric practice on January 19, 1847, when he did a version and extraction (De Lee). In the United States at the present time, ether is probably used at the time of delivery to a greater extent than any other anæsthetic. Because of the safety with

which it can be administered, its hypnotic and anæsthetic effects upon the patient, and the property which it has of depressing the intensity and frequency of the contractions of the uterus, ether can be regarded as an invaluable drug not only in unobstructed labor but particularly in the dystocias which are terminated vaginally.

One may control the contractions of the uterus with ether, at will. In direct proportion to the depth to which this anæsthetic is administered are the intervals between contractions prolonged and the intensity decreased, and they can be entirely obliterated when the concentration of ether has reached the surgical degree. Conversely, as the ether absorbed by the patient is eliminated, the contractions begin to recur and increase in intensity and frequency at about the same rate at which they were decreased. This property of ether is often a life saving virtue, as when rapid intra-uterine manipulations must be carried out, when excess uterine pressure is being exerted upon the fetus, when a contraction ring must be relaxed, when the danger of rupture of the uterus is imminent due to a weak hysterotomy scar or to the

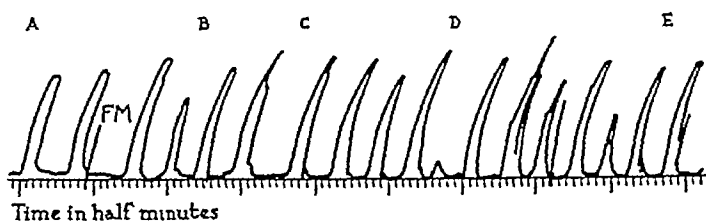


Fig 19 Normal contractions, first stage of labor in a primiparous patient, cervix dilated four fingers, left occipito-anterior position *A*, Patient very uncomfortable, effect of morphine and scopolamine wearing off, *FM*, fetal movements, *B*, contractions painful, *C*, patient restless, *D*, patient in need of further analgesia, *E*, cervix fully dilated

this gas may even stimulate or increase uterine contractions. Other investigators have made the same observations (Danforth and Davis).

At *C* in Figure 14, nitrous-oxide-oxygen gas was started and given continuously. The patient was not completely unconscious during this period but the concentration of gas was sufficient to remove all sensation of pain. The contractions continued at approximately the same frequency with a noticeable tendency to an increase in intensity. At *A* in Figure 14A (the same patient) the concentration of the gas mixture was increased so that 10 minutes later the patient was completely anesthetized. The contractions continued at the same frequency. At the point where complete anesthesia occurred the tonicity of the uterus was greatly increased, evidenced by the rise of the base line, and the contractions became more regular. Although the patient showed no external evidence of asphyxia it probably occurred to a certain degree in the uterine tissues, causing the slight incomplete tetany—the incomplete relaxation phases. The palpating hand, alone, would not be able to determine this change, and it is therefore important to realize that a fetus may be subjected to increased pressure and be deprived of a certain amount of oxygen exchange, when nitrous-oxide-oxygen gas is administered for any length of time to more than an analgesic degree.

Internal podalic version, the decomposition of a frank breech presentation into a footling, or even the manual removal of an adherent placenta, can not be safely or conveniently done under this anæsthetic. The reasons are apparent.

Spinocain The use of spinal anæsthesia in obstetrics has had its days of enthusiasm and its days of derision, and today there are reports which deny the dangers and complications which other reports charge, accompany its use. With the possible exception of satisfactory local anæsthetic infiltration, the consensus of opinion seems to favor the use of spinal anæsthesia for abdominal delivery where respiratory, cardiac, or systemic contraindications to general anæsthesia exist, just as in general abdominal surgery.

For the delivery of women vaginally, there seems to be a general appreciation of the unreliable action of the spinal anæsthetic (DeLee and Greenhill, 10) upon the tonicity of the uterus and cervix, in addition to the effect which the drugs used may have upon blood pressure, blood loss, and the nervous system. Shock and collapse also occur now and then, and vomiting is sometimes a complication.

Whitehouse and Featherstone, in 1923, described the effect upon the uterus of injecting tropacocaine into the spinal cord with the following: "When the lumbar cord is paralyzed by the drug, the uterus always

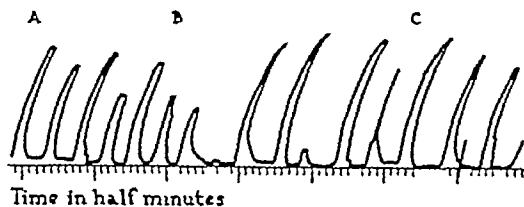


Fig 19 A Contractions of the uterus after colonic instillation of ether without quinine. (Compare with Figure 19) *A*, Fifteen minutes after administration of colonic ether, 2 ounces without quinine, *B*, patient sleeping during and between pains, *C*, patient apparently very comfortable

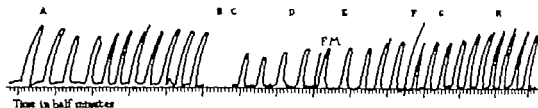


Fig. 12. The effect of colonic ether with quinine upon the contractions of the uterus. Patient was a primipara, cervix was two and one-half fingers dilated, vertex, left occiput anterior. A Patient restless and uncomfortable, during and between pains; B colonic ether instillation, quinine with 10 grains quinine; C, 15 minutes after instillation, D patient comfortable and does not complain or become restless, FM (fetal movements); E, intervals between pains greater and intensity decreased; F cough; G contractions becoming more frequent and intense, but patient is sleeping; H contractions similar to those before instillation, patient comfortable.

inadvised administration of an oxytocic as well as when many other conditions may arise where labor must be stopped.

Figure 11 demonstrates most conclusively the effect which ether has. The tracing represents a multiparous patient who at the point A is entering the second stage of labor. She has been allowed to have three second stage contractions (characterized by the superimposed tracings of additional abdominal pressure) before ether was begun. The first effect of the ether is to remove the semi-voluntary "bearing down" efforts, at point B then to decrease the intensity of the contractions and finally to obliterate them almost entirely.

Ether is also very satisfactorily used for its pain alleviating qualities alone—as an analgesic. When given in approximately 1 dram doses, in a partially dosed mask or cone at the beginning of each contraction, the sensation of pain is almost entirely removed and the progress of labor is not impaired. Figure 12 is a tracing of a patient similarly treated, and no influence upon the force or frequency of the contractions is noticeable.

When ether is used as an analgesic, the depth at which it is being given can be increased so that as the time for delivery approaches the patient is anesthetized. At the Cleveland Maternity Hospital this method is used almost to the exclusion of any other. When the patient is ready to be delivered, she is anesthetized to the extent that the uterine contractions are almost entirely obliterated so that the preparation of the field of operation may be carefully done and the perineum

well dilated manually. In the event the delivery necessitates some intra-uterine manipulation as in podalic version and extraction, or simple extraction for breech presentation, the anesthesia is continued until these maneuvers are completed. However if the patient is to be delivered with forceps the ether is removed after the forceps are applied so that the contractions may recur. Traction on the forceps is made then with each contraction. When the head is brought down to that plane in the pelvis where the chin can be felt through the perineum, the forceps are removed and the anesthesia reinforced. The head is then delivered under the complete control of the operator and he may extract it slowly and with care, preserving the perineum to the greatest extent. Figure 13 represents a tracing of a typical low forceps delivery with ether anesthesia, in a primiparous patient.

Nitrous-oxide-oxygen gas. Priestly about 1776 first prepared this gas, and its anesthetic properties were first described by Humphrey Davy and by Wells. Edmund Andrews, of Chicago in 1868 was the first to administer it combined with oxygen, as a safe and satisfactory anesthetic (Sollman, Luckhardt).

When nitrous-oxide-oxygen is administered during labor it acts purely as an anesthetic or analgesic, with no depressant effect upon the contracting uterus. I have been unable to cause any cessation or diminution of the frequency or intensity of the contractions regardless of the depth to which the gas had been administered. On the other hand, several of the tracings bear out the contention that

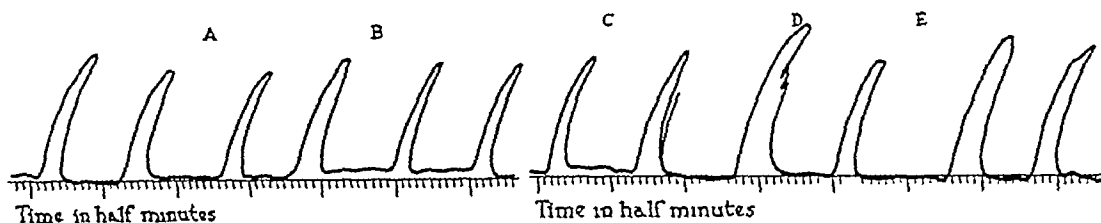


Fig 21 The regular contractions of the uterus during labor of a multiparous patient, in first stage, no analgesia or anæsthesia A, Contractions painful, B, patient restless

Fig 21 A Tracings demonstrate no immediate effect upon the contractions of the uterus after the oral administration of sodium amytal, 12 grains C, 12 grains sodium amytal was given by mouth, D, contractions harder, E, patient sleeping soundly between contractions, is only very slightly restless during pains

occasionally has the effect of hastening labor, in others it may have no effect upon the progress of labor, in another group it may retard progress for a very short time, and in nearly all patients it affords temporary relief from suffering

Generally, experimental evidence regarding the action of this drug upon the contractions of the uterus in labor pretty well fits in with Hensen's opinion, that in moderate doses morphine has little or no effect Rucker (29), however, demonstrated a tracing made by internal hysterography, in which there was decided diminution in the frequency of the contractions after the hypodermic administration of $\frac{1}{6}$ grain of morphine, and at the same time called attention to the clinical fact—often observed in practice—that an increase in uterine contractions may follow a small dose of morphine

In animals morphine has no effect upon the normal contractions of the uterus *in situ*, but when applied to the excised uterus, the tone is somewhat increased (Sollmann, Barbour, Barbour and Copenhaver)

The several observations which I have made upon the human uterus in labor after the administration of morphine agree with those made by the investigators quoted above In addition I also have tracings which would seem to agree with the results of Bourne and Burn (5) who say "Morphine lessens the frequency of uterine contractions, but the pains pass off more slowly"

These writers assume, however, that since the contractions pass off less quickly than before, the work done by the uterus is probably as great or even greater than before, despite the lessened frequency I believe that this conclusion is not soundly based, since it

is not the tightly contracted organ which is of value, from the mechanical standpoint, but that it is the period of increase, or increment of the contraction which is effective

Figures 16, 16A, and 16B illustrate the average effect of $\frac{1}{4}$ grain of morphine upon a primiparous woman in early first stage labor Fifteen minutes after the administration of the drug, hypodermically (Fig 16), the patient began to feel sleepy and for the next 15 minutes the intensity of the contractions appear to have been lessened to a slight degree, although the time intervals of recurrence are maintained For the next 45 minutes (Fig 16A) the contractions again reach their former intensity but the intervals between them are very slightly prolonged, and the periods of relaxation for each individual contraction are increased Thereafter, the tracings return to their appearance before the administration of the narcotic It is most noteworthy that not only did the patient have an almost complete rest for over $1\frac{1}{2}$ hours, from the effect of the morphine (and at the end of that time she was merely aroused by

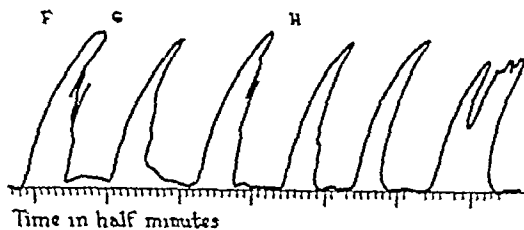


Fig 21 B F, One hour and forty-five minutes after sodium amytal was administered Contractions regular and forceful patient comfortable G, Contractions more frequent and stronger, H, patient sleeps very soundly between pains Moves about with pains

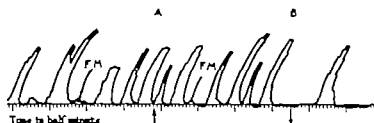


Fig. 30 A Normal contractions before the rectal insufflation of avertin. Primipara, first stage; no analgesia or anesthesia. FM, Fetal movements. A three fingers' dilatation. B avertin given per rectum, 60 milligrams per kilogram.



Fig. 30 A. The effect of avertin upon the contractions is to prolong the latent phase. (Compare with Fig. 30) C Patient asleep D patient becoming restless, less than 1 hour after avertin four fingers dilatation

contracts and it does not relax until the drug ceases to act. Metzger since that time, concluded that the injection of 0.7 cubic centimeter of a 10 per cent solution of stovaine provoked a hypertonicity of the uterus, and Bourne and Burn conclude that stovaine intraspinally does not inhibit the contractions of the uterus but interferes with complete relaxation between pains.

On the other hand J W Kelso says that caudal anesthesia produces a certain amount of inertia of the uterus in practically every case while Henry and Jaur report that if epidural anesthesia is given too high there is danger from uterine hemorrhage due to inertia and that in the low type there is no uterine anesthesia.

For the purpose of study we have injected "spinalin" intraspinally and have recorded the contractions of the uterus before and after. Figure 15 represents the contractions of a primiparous patient (9 centimeters dilated) before 2 cubic centimeters of spinalin were injected at point x. Figure 15A represents the immediate uterine reaction—a diminution in the frequency and in the intensity of several contractions for a period of

30 minutes before they resumed their previous character and a rise of the base line indicating relaxations to a less degree than before the intraspinal injection. The increased tone persisted for 45 minutes until, in Figure 15B the relaxations between contractions seemed to fall to the original base line.

The patient was free of labor pains for nearly 2 hours after the injection the region of anesthesia extending from the costal margins. However the cervix was not completely dilated until nearly 4 hours after the spinal injection and ether inhalations had to be given to alleviate the recurring pain. It is interesting to note in this case that when delivery was attempted the vertex was found to be in the left occipitoposterior position and above the brim of the pelvis and that attempts to deliver by internal podalic version were frustrated by a tonic uterus. Laparotrachelotomy was resorted to. The patient made an uneventful recovery and the condition of the baby was good.

Morphine. Clinical experience with the administration of morphine during labor indicates that the action of that drug is not always the same. Upon some patients it

ether If the morphine-scopolamine routine is carried out with due regard for the time of expected delivery, no baby suffers any respiratory depression from the drugs If a baby does have simple asphyxia at the time of delivery, the delay in respiration is not due to the hypodermic analgesia, but rather to its having absorbed a share of the general anaesthesia which made the mother unconscious Gentle manipulations invariably start respiratory efforts, and regular normal breathing follows immediately thereafter

Scopolamine combined with morphine has no characteristic effect upon the uterus in labor, other than that which is seen from morphine alone Just as morphine generally does not interfere with the normal progress of labor to any appreciable degree one way or the other, so is it when the treatment described at length above is given Figures 17 and 17A give a fair idea of the usual effect

In the first series (Figs 17 and 17A) there is somewhat of a depression in the intensity of several of the contractions following the initial dose, but labor continued After the effect of this hypodermic injection seemed to have worn off—a period of about 45 minutes—the contractions assumed their previous degrees of intensity, despite subsequent administrations of scopolamine alone The patient was relieved of all mental anguish and whatever suffering she may have had was manifested only by her restlessness during contractions as labor advanced

Gwaltney mixture No 2 On May 11, 1923, James T Gwaltney, M D, et al, with a vision toward an ideal, presented a preliminary report before the Atlantic City Medical Society, entitled, "Painless Childbirth by Synergistic Methods" (14) This was the first chapter in the history of what has now become a nationally known and widely used method for alleviating suffering during confinement It has no doubt been one of the better contributions in the way of a safe and almost "fool-proof" analgesia for general use in obstetrics, since the beginning of this century His recent report (13) including a study of more than twenty thousand cases, proves conclusively the value of the method in general obstetric practice

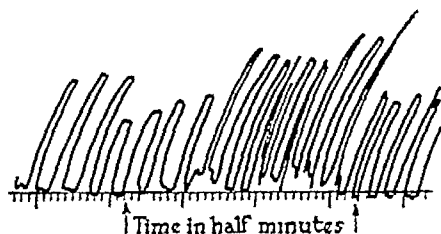


Fig 23 These tracings represent the effect of thymophysin—Temesvary—upon the uterus in labor Note the increased frequency, intensity, and tonicity, and compare with Figure 22 Patient was a 11 para, cervix was dilated three and one-half fingers, presentation was right occipito-anterior The first arrow indicates the injection of 7 minims of thymophysin, the second arrow, beginning relaxation

The Gwaltney technique (8) is not followed implicitly in the Maternity Hospital of Cleveland, but the ether-oil colonic instillation, somewhat as he describes, is very often used as a supplementary analgesia in primiparous patients who are being carried on morphine-scopolamine, and in multiparous cases, combined with the oral administration of "sodium amytal"

The mixture No 2 which we use is composed of 2 5 ounces of ether, 3 drams of alcohol, quinine hydrobromide 10 grains, and sufficient liquid petroleum to make a 4 ounce mixture This mixture is used by us very often, and its effect when administered rectally has a profound tendency, in most instances, to give the patient relief from pain and to cause sleep for varying lengths of time Its effect upon the contractions of the uterus are almost nil, and are so slight as to be ignored, although there may be a period of from 5 to 10 minutes after the administration of the mixture in which the contractions are slightly decreased in intensity But this very slight *prolongation* of labor is certainly compensated for in the comfort of the patient

Figure 18 is typically representative of what happens to the contractions of the uterus after a colonic instillation of ether-oil, containing quinine

Gwaltney mixture No 3 This mixture does not contain any quinine or alcohol and is occasionally used by us in any case where possible stimulation of the uterus is to be avoided, as in patients who have had previous caesarean sections, or where the contractions are already extremely intense and recur very

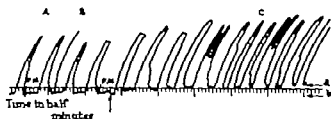


Fig. 22. The action of 3 minutes of pituitary extract upon the first stage contractions is to increase the force, frequency and tonicity of the uterine contractions. Second stage, vertex at low axis, left scapulo-anterior. F.M. Fetal movements; A three and one-half fingers' dilatation, B cough arrow indicates injection of 3 minutes of pituitaria, C cervix near full dilatation.

the contractions) but that labor progressed, the cervix dilating from approximately 1 centimeter to 3 centimeters.

Since morphine has no marked or prolonged depressing effect upon the uterine contractions of an established labor it is often used as a test to differentiate true from false labor. Almost invariably morphine will stop the contractions of the uterus when labor is false.

Reference was made in a preceding paragraph to the occasional clinical effect of morphine—its stimulating action. Often a patient who has been in labor for some time and has made little or no progress, is given a hypodermic of morphine and shortly thereafter the cervix is completely opened and delivery may follow at once. This reaction is probably due to a combination of the relaxation of the cervix, an increased tonicity of the uterine muscle and a general refreshment of the whole organism resulting from induced psychic tranquility.

Morphine and scopolamine. In 1901 V. Steinbruechel (34) first used morphine and scopolamine in obstetrics and Gauss and Kroenig a clinical use of this combination in the University Women's Hospital of Freiburg is well known. The first years of the combined use of these drugs were limited to Europe, and after a wave of enthusiasm in the United States subsequent to that time it was more or less abandoned as a routine analgesia in labor. However in a few clinics in this country at the present time "twilight sleep" analgesia is used but the method is a modification of the original Freiburg method (De Lee). For two decades the use of morphine and scopolamine has been routine for pri-

mi-parous patients in the Cleveland Maternity Hospital, and there has never been any question of discontinuing its use (BIII).

On the basis that if given too close to the time of delivery it may cause depression of respiration in the baby the treatment is not started when delivery either vaginally or abdominally is expected within 4 hours. Other than for this contra-indication, morphine and scopolamine are never denied a patient.

As soon as a primiparous patient begins to complain of pain or discomfort she is given 1/6 grain morphine and 1/150 grain scopolamine hypodermically. Forty five minutes later a hypodermic injection of 1/300 grain of scopolamine is given to be followed in another 45 minutes by 1/400 grain of the same drug. From that time on she receives every 1 1/2 hours, subsequent doses of 1/400 grain until it is estimated that the patient will be ready to be delivered in 3 to 4 hours. Occasionally a dose of scopolamine during the course will be combined with an additional dose of morphine 1/6 grain, if the course of labor is unusually slow or if the patient seems somewhat restless. Amnesia is complete in the greatest majority of patients, and once in a while a patient may recall some unimportant incident concerning her care or an examination but there is no memory of pain.

Since delivery of a patient usually occurs within 2 to 2 1/2 hours after the beginning of second stage labor the injections of scopolamine are stopped when the cervix is dilated about 8.5 centimeters and analgesia is continued by inhalations of ether or nitrous oxide-oxygen or a colonic instillation of

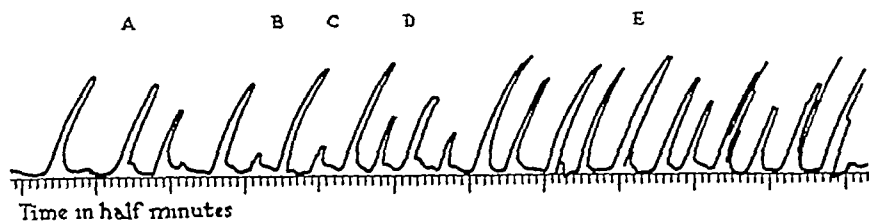


Fig. 25 The possible effect of the administration of quinine sulphate upon the labor of a primiparous patient. Some increase in frequency and intensity of the contractions is noted 15 minutes after the drug was given, which action may have been due to the drug. 4, Cervix three fingers dilated, patient had had no analgesia or anæsthesia, B, contractions very painful, C, quinine sulphate, 10 grains, D, patient restless, E, patient very uncomfortable

general condition Avertin should only be given when ample assistance is available in case untoward reactions occur, and equipment for carbon-dioxide-oxygen administration should be at hand. A patient can not be left in the care of any one other than an anæsthetist or very well trained nurse assistant after the administration of avertin, but a student nurse can easily be trusted with the welfare of a patient after colonic ether-oil.

An examination of Figures 20 and 20A will reveal a prolongation of the intervals between the contractions after the instillation of avertin, as compared with those before the drug was given.

Sodium amytal Doctor Bill suggested the oral administration of sodium iso-amyl-ethyl barbiturate, or "sodium amytal Lilly," in 3 grain units, for multiparous patients, at the Cleveland Maternity Hospital, about 2 years ago. The analgesia and amnesia which this drug produced during the first stage of labor in doses from 9 to 15 grains was most gratifying and its use is now a regular part of the analgesia routine for multiparæ. Combined with colonic instillations of ether-oil, patients are very satisfactorily carried through the greater part of the first stage of labor. With inhalation anæsthesia for delivery, childbirth and confinement becomes practically painless for the multipara to whom one might hesitate to give morphine hypodermically because of the uncertainty of the time of delivery with consequent respiratory depression of the baby.

Soon after she is admitted, the multiparous patient is given 9 grains of the drug by mouth, and within 15 to 20 minutes the patient is usually sound asleep and may not even

stir during contractions. The average patient rests from 1½ to 2½ hours with this dose, and when sleep becomes light a subsequent dose of 3 to 6 grains may be given without hesitancy. Whenever it is considered desirable, ether-oil is given by rectum, and there are no contra-indications to the combination of these two preparations except those local conditions of the descending colon and rectum which preclude the ether-oil.

There has never been any apparent danger to the baby from sodium amytal, but very occasionally a patient has become excited rather than tranquil from its use. In the latter cases, ether-oil by rectum (which may be repeated in 3 to 4 hours) usually suffices to quiet the patient.

Sodium amytal has absolutely no depressing effect upon the contracting uterus in labor, nor does it have any tendency to interfere with complete relaxation of the uterine musculature in the intervals between contractions. On the other hand, the drug seems to cause a very desirable relaxation of the lower uterine segment. Dilatation of the os is, therefore, often more rapid than would ordinarily be expected, and for this reason the contractions often become more intense—but not painful—under the influence of this hypnotic.

The series of tracings in Figures 21, 21A, and 21B are most interesting. In the first is represented the regular painful contractions of the first stage of labor in a secundipara, who had had no medicaments for the relief of her suffering. At point C in Figure 21A, 12 grains of sodium amytal were given by mouth. Despite the fact that the contractions became

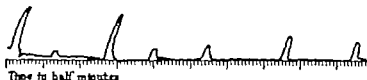


Fig. 24. "False labor pains induced in a primipara at term, by the administration of 10 grains of quinine sulphate orally. Quinine had been given 30 minutes before starting tracing. Patient was delivered after a period of complete cessation of contractions about 73 hours later.

often. Although the effect of quinine upon the uterus, in labor is said to be one of stimulation it is well known clinically that it actually falls in many instances. However this drug is excluded, for theoretical if not for practical reasons, in the conditions already mentioned.

There is only a very little contrast between the tracings taken where quinine was included and where it was excluded in the colonic instillations.

Figure 19A illustrates the tracings recorded upon a primiparous patient for 35 minutes beginning 15 minutes after a colonic instillation of ether without quinine. Very little if any marked difference can be seen in these tracings and those of Figure 19 taken over a period of 50 minutes before the analgesia was given.

Avertin tribromethanol or avertin fluid which has had a rather wide usage in Europe as a rectal anesthetic for surgical cases has been recently used in the United States in weaker concentrations for obstetrical analgesia. All reports regarding its value are not equally enthusiastic but most of the writers agree that close watch must be kept for evidence of respiratory depression and lowered blood pressure.

Deaths due to this drug have been reported in the literature but Naujoks believes that not all of them were due to the drug itself but rather to excessive doses or faulty technique. The important thing however is that deaths have followed its use.

Avertin does produce anesthesia, and in smaller doses analgesia, but as Barlow et al., of Western Reserve University have pointed out in their experimental study of the preparation, in rats, the duration of the maximal action is quite limited. It is, therefore best given in general surgery as a preliminary to a

fortifying general or local anesthesia and given in obstetrics, in concentrations not so great, as an analgesia at the end of the first stage with a general anesthetic for delivery.

I have found that avertin given by rectum in the proportion of 60 milligrams per kilogram of body weight—the recommended concentration for obstetrical analgesia—has no marked influence upon the contractions of the uterus other than to prolong greatly the intervals between them for about 45 minutes after the administration. During this period, the patient is usually very quiet and sleeps, but very frequent observations are made of her blood pressure and respiratory rate during the first 15 to 30 minutes of this period of rest. When the effect of the medication begins to wear off at the end of 45 to 50 minutes following its administration, the uterine contractions resume their former frequency and painfulness and the patient becomes restless, occasionally unmanageable. Inhalation analgesia is invariably resorted to in order that the patient may be kept comfortable.

Although this preparation does produce satisfactory analgesia there seems to be nothing to recommend its use when compared with the rectal instillations of ether-oil mixtures for the same purpose. As a matter of fact, comparison highly recommends the latter. Avertin when given in a comparatively harmless dose gives a period of analgesia and rest which at its best does not extend over 45 to 50 minutes whereas the Gwathmey mixtures produce a period of rest and relaxation free from pain for an hour as an average and a subsequent period of from 30 minutes to an hour of comfort. Uterine contractions are interfered with to a less degree by colonic ether-oil instillations and it is unnecessary to take special precautions for the safety of the patient's

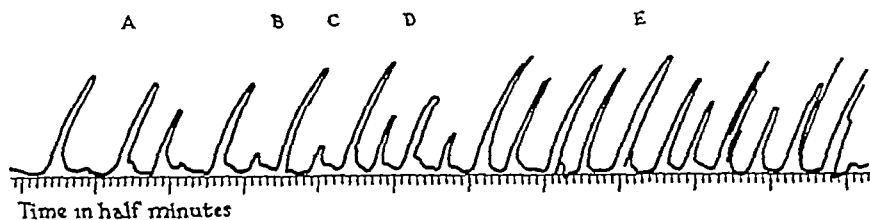


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more intense, the patient was soundly sleeping in less than 20 minutes, moving about somewhat but not complaining during the contractions. One hour and forty five minutes later (Fig. 21B) the patient was still asleep between contractions and stirred only during them. There was still no evidence of suffering 2 hours and 20 minutes after the drug had been given, when the tracings were discontinued. It is most apparent that labor continued uninterruptedly.

Pituitary extract In 1927 when Bourns and Burn (4) were investigating the dosage and action of pituitary extract before delivery they found that in nearly half of the primiparous labors which they studied by internal hysterography the uteri became tonically contracted after the injection of two units of pituitary extract, and the increased tonicity persisted from 10 to 30 minutes.

Rucker (28) in 1925 came to the same conclusion regarding the action of pituitary extract, referring to the incomplete relaxation of the uterus as an "incomplete tetany" and demonstrated tracings which were made by this method of hysterography to substantiate his opinion.

My findings, recorded by external hysterography concur entirely with those of these investigators. Although the intensity and frequency of the contractions were definitely increased and labor progressed in those cases in which the cervix was dilated from 7.5 to 8 centimeters, the degree of relaxation between contractions was not complete after the injection of 2 to 3 minims of pituitary extract, hypodermically. The period of this increased tonicity averaged about 25 minutes.

With doses as small as those which were used in this study it is not very possible to do a great deal of harm, especially when either was easily available for administration if it were necessary to retard or subdue tempestuous contractions. However it is at once most evident that terrific damage might be done if larger doses were injected—(and the literature of the past 16 or 17 years is full of reports of fatal and disastrous results) while the fetus remained *in utero*.

Pituitary extract is a powerful, quickly acting and tenacious oxytocic, and although

it is of value in isolated instances of uterine inertia during the first or second stage, when administered at intervals of 1 or 2 hours in small doses of 1 or 2 minims by a competent and well trained obstetric surgeon, it is a terrible and dangerous drug when given without regard for its potency or dosage, or maternal and fetal tissues merely to hasten delivery. Because of the very properties of the drug which contra indicate its usage almost invariably in first and second stage labor it is an invaluable addition to the obstetrician's armamentarium during and after the third stage.

Arrow *a* in Figure 22 points to the base line assumed during the intervals between uterine contractions, in a secundiparous patient, after the injection of 3 minims of pituitary extract as compared with the original base line before the injection, indicated by arrow *b*. At the end of 23 minutes, in this tracing the uterus was still in a state of "incomplete tetany" with no indication that it would soon relax.

With these findings in mind too much stress can not be laid upon the tragic dangers of pituitary extract inadvisedly used and even in this year of 1932 a word of caution is not amiss.

Thymophysin With complete regard and respect for the report of the Council on Pharmacy and Chemistry of the American Medical Association which has investigated thymophysin through the research study conducted by Dr. Erwin E. Nelson, of the University of Michigan, the author presents his findings.

The data concerning the exact nature of the preparation was not known at the time these studies were begun, until Nelson's report appeared, but clinical and hysterographic experience with the substance was practically identical with that of pituitary extract.

Nelson concludes that when thymophysin (a mixture of extracts of pituitary and thymus) and equivalent doses of pituitary extract were compared upon excised uteri or on the blood pressure, no differences in action could be demonstrated.

Rucker (30) investigated the action of this mixture upon the pregnant human uterus *in situ* and found that in doses of from 0.5 to 1 cubic centimeter it caused tetanic contrac-

tions similar to the action of pituitary extract, and vigorously condemned it

Three studies which I made gave recorded tracings very similar to those seen during the investigation of pituitary extracts—an increase in frequency and intensity of the contractions with a lessened degree of relaxation between contractions. Figure 23 is typical after the injection of 0.5 cubic centimeter

If an oxytocic with the properties of pituitary extract is desired, let pituitary extract be used. Pituitary extract is standardized, its dangers in first and second stage labor are widely known, and its virtues in third stage labor are recognized. Thymophysin is an unstandardized preparation of varying potency extended to the medical public with glowing promises for its ability to shorten labor safely—and already a case of rupture of the uterus has been reported following its administration.

Quinine Sollman says that quinine stimulates the contractions and increases the tone of the excised uterus. De Lee (9) gives the percentage as 30 of all cases of women at or near term who begin to have labor contractions after the administration of quinine and says that, during labor, quinine occasionally may aid the weak contractions of an uterine inertia.

Yet it is known clinically that very often quinine has no apparent effect, even when given in repeated doses, and that it may, on the other hand, cause fairly severe increase in tone and intensity of the contractions. Its effect in 10 grain doses, by rectum, has been considered under the discussion of rectal analgesia.

We tried quinine in 10 grain doses in 3 patients at term who had had no labor contractions. In two of these instances there was no stimulation of contractions but, in the third, feeble pains occurred which lasted for about 45 minutes and then subsided completely for 72 hours, when labor started spontaneously (Fig. 24).

Figure 25 represents a typical patient in established labor who was given 10 grains of quinine. A slight increase in the force of the contractions seems to have followed, but with no appreciable effect on the course of labor.

It appears from these few observations, and the observations of others in the clinical-experimental use of quinine in labor, that the powerful effect of quinine upon the excised uterine muscle suspended in a bath is a very unsatisfactory guide to its effect upon the parturient human uterus and that its value in parturition has been overstressed.

SUMMARY

1 A review of the history of methods which have been hitherto used for the purpose of studying the contractions of the human uterus during labor has been made and presented.

2 An original method for external hysterography has been devised and described, whereby tracings of the contractions of the human uterus in labor may be easily and conveniently made during the phase of the first or second stages of labor. This method is entirely harmless so far as the patient or fetus is concerned, and can be satisfactorily applied and used without aid.

3 Tracings have been exhibited, demonstrating the normal first and second stages of labor and their characteristics have been pointed out.

4 The reactions of the uterus during labor and at term to some twelve drugs have been studied graphically to correlate previous clinical impressions with experimental evidence.

5 Ether depresses the contractions of the uterus in direct proportion to the depth to which it is administered, and when given as an analgesic in a semi-closed mask in dram doses it relieves pain but does not retard the progress of labor.

6 Nitrous-oxide-oxygen gas when given either as an analgesic or anæsthetic has no depressant effect upon the contracting uterus. When given to the degree of surgical anæsthesia it may cause an incomplete relaxation of the uterus between contractions, with the consequent possible danger of excess pressure upon the fetus.

7 Novocain, given intraspinaly in the form of spinocain causes complete anæsthesia for about 2 hours, with a short period of depression upon the uterine contractions. This

drug induces an increased tonicity of the uterine tissues.

8 The action of morphine sulphate in labor is almost always to give temporary relief from suffering but the effect upon the contractions of the uterus in established labor is not marked. Occasionally it may depress the contractions for a short time but it retards labor an unappreciable amount.

9 When scopolamine is combined with morphine the effect upon the uterus is practically the same as with morphine alone. This combination when given as described, makes an excellent analgesia for primiparous patients, with no ill effect to the mother or to the fetus.

10 The colonic instillation of ether with and without quinine, has practically the same effect—to give excellent analgesia with a very slight depression of the contractions of the uterus.

11 Avertin, or tribromethanol, given rectally in the dose of 60 milligrams per kilogram of body weight as an analgesic, is unsatisfactory and has no virtues which recommend its use in the dosage mentioned. It does not depress the contractions of the uterus but prolongs the intervals between them on the other hand the analgesia does not last sufficiently long to warrant the special care and concern which all patients who have received the drug must get. Many patients become unmanageable when the effect of the drug becomes light. Colonic ether is by far a more superior analgesic for rectal administration.

12 Sodium amytal (sodium iso-amyl-ethyl barbiturate) is an excellent analgesic for oral administration especially in multiparous patients and when combined with rectal ether oil instillations gives a practically painless confinement and childbirth. It does not retard labor at all in spite of the fact that with from 6 to 12 grains of the drug patients may rest or even sleep from 1 to 3 hours with no discomfort. Its value can not be estimated too highly and there is no evidence which points to any harmful effect upon mother or child.

13 Thymophysin, an extract of thymus and pituitary has been considered an unstandardized and unsafe preparation by the

American Medical Association and its use to shorten labor has been condemned. Its action is identical with diluted extracts of pituitary and should be entirely avoided. When a powerful oxytocic is desired, a standardized and known preparation of pituitary gland should be used.

14 Pituitary extract given hypodermically in doses of 2 to 3 minims stimulates the contractions of the uterus in force and frequency but it also causes an incomplete relaxation between contractions—an incomplete tetany—for a period of 20 to 30 minutes. The drug is dangerous when given inadvisedly during the first or second stage of labor.

15 The action of quinine is undependable in labor and late pregnancy but in some cases it has an oxytocic effect.

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9. When scopolamine is combined with morphine the effect upon the uterus is practically the same as with morphine alone. This combination, when given as described makes an excellent analgesia for primiparous patients, with no ill effect to the mother or to the fetus.

10. The colonic instillation of ether with and without quinine, has practically the same effect—to give excellent analgesia with a very slight depression of the contractions of the uterus.

11. Avertin, or tribromethanol, given rectally in the dose of 60 milligrams per kilogram of body weight as an analgesic, is unsatisfactory and has no virtues which recommend its use in the dosage mentioned. It does not depress the contractions of the uterus but prolongs the intervals between them. On the other hand the analgesia does not last sufficiently long to warrant the special care and concern which all patients who have received the drug must get. Many patients become unmanageable when the effect of the drug becomes light. Colonic ether is by far a more superior analgesic for rectal administration.

12. Sodium amylal (sodium iso-amyl-ethyl barbiturate) is an excellent analgesic for oral administration especially in multiparous patients and when combined with rectal ether oil instillations gives a practically painless confinement and childbirth. It does not retard labor at all in spite of the fact that with from 6 to 12 grains of the drug patients may rest or even sleep from 1 to 3 hours with no discomfort. Its value can not be estimated too highly and there is no evidence which points to any harmful effect upon mother or child.

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American Medical Association and its use to shorten labor has been condemned. Its action is identical with diluted extracts of pituitary and should be entirely avoided. When a powerful oxytocic is desired, a standardized and known preparation of pituitary gland should be used.

14. Pituitary extract given hypodermically in doses of 2 to 3 minims stimulates the contractions of the uterus in force and frequency but it also causes an incomplete relaxation between contractions—an incomplete tetany—for a period of 20 to 30 minutes. The drug is dangerous when given inadvicely during the first or second stage of labor.

15. The action of quinine is undependable in labor and late pregnancy but in some cases it has an oxytocic effect.

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Fig 1, left. Rabbit 828 Liver and spleen fairly well outlined

Fig 2 Same animal, 2 days later

of the injection there is damage to the overloaded reticulo-endothelial system which seems to become repaired in the later periods

It may be of interest to point out that two animals (167 and 195) died 18 and 26 days, respectively, after the injection of thorotrast. The amount of thorotrast that these two

animals received was reported as a non-toxic dose by Radt. It is possible that the deaths were due to a late harmful effect of thorotrast on liver or spleen or both organs

Thorotrast has been used in 6 cases on the wards of Mount Sinai Hospital. This group of patients had a large liver or spleen or

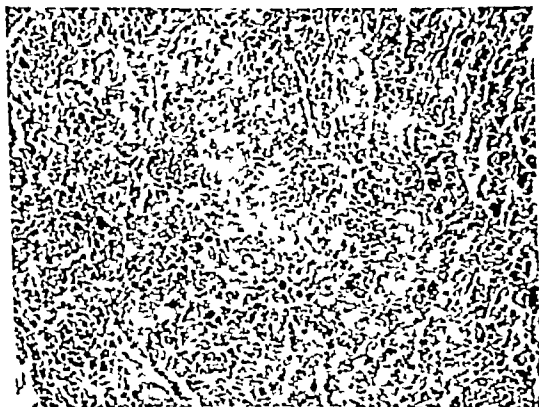


Fig 3 Low power photomicrograph of section of spleen from same animal as shown in Figure 1

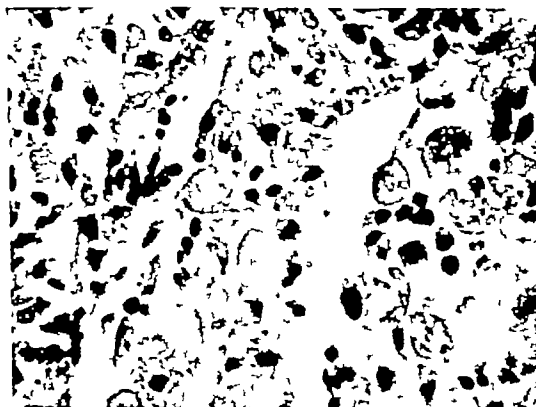


Fig 4 High power photomicrograph of section of spleen from same animal as shown in Figure 1

HEPATO-LIENOGRAPHY WITH THOROTRAST

RICHARD LEWISOHN M.D. F.A.C.S., New York

From the Surgical Service of Mt. Sinai Hospital

THE satisfactory roentgenological demonstration of liver and spleen is still an unsolved problem. Though the outline of spleen and liver can sometimes be seen on flat X-ray plates or with the aid of a pneumoperitoneum, no details of structure, either normal or pathological can be visualized on the films.

Radt^{1,2} and Oka³ have recently advised the intravenous injection of thorium preparations to demonstrate roentgenographically pathological changes in these organs. They found that upon intravenous injections certain colloidal substances are deposited as fine granules in the reticulo-endothelial system of the spleen and in the Kupffer cells of the liver. Radt used a thorium-dioryd solution which is called thorotrast. Thorotrast is prepared by the Heyden Chemical Company in ampuls of 15 cubic centimeters. They have recently made larger ampuls of 25 cubic centimeters each. Thorotrast is injected intravenously on 3 or 4 successive days. The patient is roentgenographed on the fourth or fifth day.

The injections are not followed by any immediate ill effect. No rise of temperature, chill or vomiting were observed in any of the cases. It is possible, however, that thorotrast may cause harmful late effects, as the major part of the injected substance seems to remain in the liver and spleen more or less permanently.

Before reviewing the clinical results in 6 cases in which thorotrast was used I would like to report on some animal experiments which were performed on rabbits.

Animal 823. Weight 2500 grams. April 1, 1931. 3.2 cubic centimeters of thorotrast was injected into an ear vein. Roentgenogram made April 3 showed both liver and spleen moderately well outlined (Fig. 1). Another roentgenogram taken on April 4 showed practically identical findings (Fig. 2).

In order to test the maximal toxic dose another dose (5 cubic centimeters) was given to this animal

on April 6. The rabbit died during the following night.

Microscopic examination (Dr. Klempner). There is noted in the spleen (Figs. 3 and 4) a very conspicuous increase of histiocytes which contain brown granules. The granules are apparently also stored in the syncytium, but are absent from the sinus endothelium. The stored histiocytes quite frequently show nuclear damage. The lymph nodes show a storage of brown granules in the sinus endothelium and reticulum. In the liver the Kupffer cells contain the granules. The liver cells present dark granules which differ in appearance from the colloidal granules.

Conclusions. It cannot be denied that the reticulo-endothelial system shows not only the expected storage of the colloidal material, but also changes of degenerative nature indicated by the nuclear damage. These changes may possibly be due to a toxic dose.

Animal 970. Weight 2600 grams. April 1, 1931. 3 cubic centimeters of thorotrast was injected into an ear vein. X-ray pictures taken on April 3 and April 4 showed only a dim outline of the liver (Fig. 5). The spleen was not visible.

Microscopic findings in the liver and spleen were about identical with those in animal 823. However the storage in the reticulum was less conspicuous. The lymph nodes were not examined in this case.

Animal 167. Weight 100 grams. April 4, 1931. 4.7 cubic centimeters of thorotrast was injected into an ear vein. An X-ray picture, taken on April 6, showed a very dense shadow of liver and spleen with an excellent outline of both organs (Fig. 6). The animal died on April 7.

Microscopic examination. The inter sinusoidal reticulum is crowded with very large phagocytic cells filled with the colloidal material. Nuclear damage is not conspicuous. The sinus endothelial cells do not participate in the storage to any remarkable extent.

Animal 195. Weight 1900 grams. April 4, 1931. 4 cubic centimeters of thorotrast was injected into an ear vein. An X-ray picture taken on April 6 demonstrates the spleen very clearly (Fig. 7). The liver is not clearly demonstrated. The animal died on April 30.

Microscopic examination. The amount of storing cells is still great. However, one sees between the nest of macrophages individual elements which contain either very small amount of finely granular brown material or none at all, apparently reticulum without phagocytosis (Fig. 8).

Conclusions from the microscopic findings in 4 rabbits injected with thorotrast. At the peak

Radt, Klin. Wochenschr. 1929, vol. 7, 28.

Radt, Klin. Wochenschr. 1930, No. 27.

Oka, Fortsch. Geb. Roentgenstrahlen, vol. 21 and 22.



Fig 10 L F Roentgenogram before injection of thorotrast

so that the possible presence of metastasis could not be determined. Spleen was well outlined (Fig 9)

CASE 2 328217 L F, male, aged 65 years, admitted July 17, 1931, discharged August 13, 1931. Diagnosis carcinoma of cardia with liver metastasis. Palpation revealed a firm nodular liver with an irregular edge about 5 fingers below the right costal arch. X-ray examination revealed a carcinoma at the cardiac end of the stomach (Fig 10). Examination of the abdomen after intravenous injection of thorotrast showed the liver to be somewhat enlarged. No definite abnormalities in the contour were noted. The spleen was not well demonstrated (Fig 11).

A comparison of Figures 10 and 11 shows that the liver shadow is just as well demonstrated on the flat plate as on the plate taken after the administration of thorotrast.

CASE 3 324739 S W, male, aged 40 years, admitted April 8, 1931, discharged May 9, 1931.



Fig 11 L F Roentgenogram after injection of thorotrast

Diagnosis inoperable ileocaecal carcinoma with metastasis. Nodular mass in ileocaecal region. The liver was just palpable. The spleen could be felt 2 fingers below the costal margin.

Examination of the abdomen after injection of thorotrast showed the liver and spleen to be fairly well outlined. The spleen was enlarged to a moderate extent (Fig 12). Exploratory laparotomy (Dr Aschner) showed an infiltrating lesion of the caecum with metastasis to the peritoneum and Douglas' pouch.

CASE 4 329198 R H, female, aged 55 years, was admitted August 17, 1931, discharged September 20, 1931. Diagnosis pernicious anaemia. August 18, 7200 cubic centimeters of fluid was removed by paracentesis. A mass was felt in the right abdomen (Differential diagnosis between kidney and liver). X-ray examination after thorotrast injection showed



Fig 12 S W Roentgenogram showing liver fairly well outlined



Fig 13 R H Roentgenogram showing elongated lobe of liver



Fig 14 F A Roentgenogram showing enlarged liver (carcinoma)



Fig. 5. Rabbit 970. Dissected view of liver.



Fig. 6. Rabbit 67. Liver and spleen clearly outlined.



Fig. 7. Rabbit 95. Spleen clearly outlined.

enlargement of both organs, as demonstrated by palpation. A brief abstract of the histories is given herewith.

CASE 1. 325601. R. W. female aged 53 years, was admitted May 5 1931, discharged May 7 1931. **Diagnosis.** carcinoma of the stomach with metastasis in the liver. In the right upper quadrant extending almost to the level of the umbilicus there

was an irregular and nodular mass which was attached to the umbilicus. A coarse nodular infiltration was present in the ligamentum teres. Test meal showed free hydrochloric acid 0, total acidity 50. X-ray examination of stomach showed a carcinoma. Examination of the abdomen after intravenous injection of thorotrast showed the liver markedly enlarged reaching down to the iliac crest. The lower half was obscured by intestinal shadows,

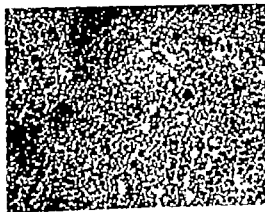


Fig. 8. Low power photomicrograph of section of spleen from same animal as shown in Figure 7.



Fig. 9. R. W. Roentgenogram showing spleen well outlined.

CONCLUSIONS

1 The intravenous injection of thorotrast in the quantities mentioned has no immediate ill effect on the patient

2 It is impossible to state at present whether the more or less permanent storage of thorotrast in liver and spleen may not be injurious to the patient

3 Thorotrast gives an outline of either liver or spleen or both organs without finer

details of structural changes in these organs Its aid in the clinical diagnosis of a pathological condition in the liver and spleen seems to be limited

4 Thorotrast cannot be compared in diagnostic efficacy with uroselectan and similar drugs in kidney diseases or lipiodol in lung diseases

I beg to thank Dr M L Sussman, assistant radiologist, for his kind co-operation



Fig. 15. Same patient as in Figure 4. Postmortem specimen of carcinoma of the liver.

that this mass was due to an elongated liver reaching down to the crest of the ileum (Fig. 13). Patient improved on liver therapy.

CASE 5. 329382. F. A. male, aged 6 years was admitted August 24, 1931; died September 16, 1931. Diagnosis: carcinoma of the liver. Jaundice was present for about 1 month. A very large liver was palpable down to 5 fingers below the costal arch. The surface was smooth. X-ray examination after injection of thorotrast showed an enlargement of the liver. The shadow of the liver was dense, but failed to give structural details (Fig. 14). Patient died September 16.

Postmortem examination showed an extensive primary carcinoma of the liver (Fig. 15). Microscopic examination of the liver showed a great number of phagocytes crowded with large granules (thorotrast) within the capillaries of the liver (Figs. 16 and 17).

In the spleen large macrophages with thorotrast granules were found within the reticulum as well as free within the lumen of the sinus.



Fig. 17. F. A. Microscopic section of liver under high power.

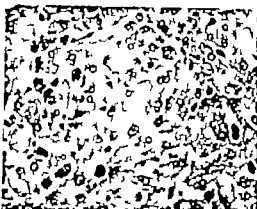


Fig. 6. F. A. Microscopic section of liver low power.

It is of interest to compare Figures 14 and 15. In spite of the fact that the liver was filled with innumerable large and small carcinomatous nodules, the thorotrast film simply showed the outline of the liver without variation of shadows in the liver substance.

CASE 6. 33004. A. S. male aged 30 years, was admitted September 14, 1931; discharged October 11, 1931. Diagnosis: cholelithiasis, common duct obstruction (?). Icterus was present for about 4 weeks. The liver was slightly enlarged.

Five doses of thorotrast (15 cubic centimeters each) were given intravenously. Examination of the abdomen after the administration of thorotrast showed the liver and spleen to be distinctly outlined. The liver was moderately enlarged in size, its lower border reaching about 4 centimeters above the crest of the ilium. The spleen was only slightly enlarged. There were no nodules or filling defects noted in either the spleen or the liver (Fig. 18).

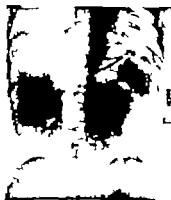


Fig. 18. A. S. Roentgenogram showing the liver and spleen distinctly outlined.

(1) extension along lymphatic channels, (2) erosion from "fixation points" in the epiphyses, (3) formation of a sinus leading into a joint by destruction of cortical and cancellous bone, (4) perforation of a subperiosteal abscess into the joint, and (5) simultaneous involvement of both bone and joint by the formation of more than one "fixation point"

Among other factors, such as an advancing thrombophlebitis, this extension to joints is influenced by variance in certain anatomical structures. It is determined to some extent not only by the attachments of the articular capsule, as pointed out by Reich, but also by the reflexions of the synovia, occurring most frequently from bones with complete or partial intracapsular epiphyseal lines. For this reason osteomyelitis of the neck of the femur almost invariably involves the hip joint and frequently infection extends to the knee from the distal extremity of the femur, to the ankle from the lower end of the tibia, and to the elbow from the distal portion of the shaft of the humerus. The importance of the epiphyseal cartilage as a barrier to the spread of bone infection to the adjacent joint is well illustrated by the early and almost universal involvement of joints from bones in which this barrier is lacking. In point, suppurative arthritis is an almost constant complication of osteomyelitis of the small bones of the wrist and ankle. For the same reason such lateral articulations as exist between the upper ends of the radius and ulna and the lower ends of the tibia and fibula (with articular extensions above the level of the corresponding epiphyseal lines) become infected by extension from a process in the end of one of the respective shafts. These facts are well illustrated in the case analyses which are being presented subsequently.

Theoretically, it is possible for a small metaphyseal infection to extend and drain into a joint within a short time after its inception and heal promptly without producing bone destruction or leaving X-ray evidence of the primary focus in the diaphysis. It is conceivable that this may be the explanation of some cases of supposedly primary acute pyogenic arthritis. These cases might be classified as abortive osteomyelitis.



Fig 1, left Case A. Note primary localization of infection in the diaphysis of the femur at the onset of osteomyelitis in an infant 4 weeks of age.

Fig 1A Case A. The end-result 1 year and 4 months after onset. X-ray evidence of destruction in the medial half of the epiphysis was observed 14 days after the onset.

There is an abundance of indirect evidence that a chronic osteomyelitic process which has originally resulted from an acute hæmatogenous infection may become a focus in itself for the dissemination of bacterial emboli to produce remote bone or joint inflammatory processes. Occasionally, as pointed out by Wilensky (15), an old relatively quiescent lesion has been observed suddenly to show increased activity as evidenced by a recurrence of pain and an increase in drainage, then a slight rise in temperature and a few hours or days later the appearance of involvement of another bone or remote joint. Presumably a local activation takes place with thrombophlebitis and resultant bacterial metastases. This observation was made in Case 1.

Whether in these cases the infecting microorganisms are ever deposited directly in the synovia of the joint by the blood stream or are always primarily deposited in the diaphysis from whence they are aborted into the joint, is an interesting speculation. It is most probable that both processes occur. In Beelman's (3) experience staphylococcus synovial

THE RELATION OF PYOGENIC ARTHRITIS TO OSTEOMYELITIS

J DEWFFY BISGARD M.D. CHICAGO

From the Department of Surgery, Division of Orthopaedic Surgery, University of Chicago

PYOGENIC exudative lesions of joints have been classified by Kaufman as primary and secondary arthritides with reference to the avenue of entrance of the infecting micro-organisms. Primary infections may occur as the result of trauma, such as communicating puncture wounds, or a blood borne infection without evidence of a primary focus. Secondary involvement occurs either by metastasis from a remote source with conveyance through the blood stream and occasionally through lymphatic channels (Cotton) or by direct extension from an adjacent pyogenic focus (most frequently osteomyelitis).

That the primary lesions of acute hematogenous osteomyelitis are most frequently localized in the diaphyseal extremities of long bones has been well established both clinically and experimentally. Postmortem examinations of patients dying within 48 hours after the onset of symptoms, such as those reported by Starr repeatedly demonstrated this localization.

Working with rabbits Bancroft and Robertson obtained similar results and the latter reports the following observations:

"1. Organisms introduced into the blood stream are deposited among other places, in the long bones.

2. In bone there is very active phagocytosis except in the metaphysis.

3. Trauma may determine a local infection.

4. Growing bones develop abscesses of the type of osteomyelitis within their metaphyses. Adult bones do so rarely. In the presence of a bacteremia adults may acquire an arthritis.

In explanation of this phenomenon Lexer outlined the circulatory architecture of long bones by the injection of radio-opaque solutions and he demonstrated at the juxta-epiphyseal region a relatively avascular area where clumps of micro-organisms which were filtered from the blood stream readily establish a focus.

Much has been written relative to primary localization of suppurative processes in the epiphysis, primary suppurative epiphysitis. Uffreduzzi has expressed the opinion that this localization is the rule in infancy while in childhood the diaphysis is the most frequent site of the original infection. From an extensive experience and careful study Phemister (7) has concluded that primary suppurative epiphysitis rarely occurs. He has pointed out that if these cases are observed at the onset a primary metaphyseal lesion can almost invariably be demonstrated. In support of this contention and in exemplification of demonstrable direct extension to a joint Case A is presented.

CASE A. E. S. No. 12716 (Fig. 1) A girl, 3 weeks of age and with a normal birth, presented no abnormality until the onset of fussiness, swelling, tenderness, and voluntary fixation of the right knee joint during her second week of life. Examination showed a febrile child with no regional changes except for a spindle shaped, tender swelling of the lower end of the thigh and a fluctuant right knee joint with redness of the skin. On admission to the hospital the temperature was 103 degrees by rectum and the baby was not acutely ill. The blood Wassermann and Kahn, the tuberculin and uric acid tests were reported to be negative. The X-ray examination on admission showed an area of rarefaction (destruction) in the diaphysis of the lower end of the right femur. Subsequent pictures 3 months later demonstrated a progression of the process. At destruction of a large portion of the epiphysis. The knee joint was aspirated and a few days later incised and drained. The aspirated pus contained staphylococcus aureus in smears and culture. At 7 weeks of age the right shoulder joint became involved with a repetition of the course followed by the right knee joint.

Since the primary lesion usually finds its origin in the metaphyses direct extension to or perforation and drainage into the adjacent joint occurs in a fair number of cases. After a very comprehensive clinical study of joint complications in hematogenous osteomyelitis, Wilensky (14) pictures "fixation points" occurring in the diaphyses with secondary pathological progression to joints. He describes

definite history of the institution of surgical drainage of the joints. Three were drained by repeated aspirations with return of a complete range of motion, and, of the 6 treated by open drainage, 3 subsequently became ankylosed, 1 developed a full range of motion, and 2 regained about 50 per cent of normal function.

A comparison of the end-results in these two groups of cases tabulated later indicates that ankylosis results more frequently in the joints involved by direct extension than those involved presumably by metastasis.

	Direct extension		Infection by Metastasis	
	Cases	Per cent	Cases	Per cent
Ankylosis	34	65.2	4	44.5
Limited motion	12	22.6	2	22.2
Full range motion	7	13.2	3	33.3
Total joints	53		9	

CASE REPORTS

(Illustrative of metastatic hæmatogenous pyogenic arthritis)

CASE 1. R. W., male, aged 7 years (Fig. 2), admitted in September, 1929, with a history of good health until the onset of the present illness in April 1929. Three days following injury, the right heel became severely painful and the boy became delirious, with a temperature of 106 degrees F. Two days later an abscess appeared on the medial side of the right heel, and the patient was taken to a hospital where drainage was established. In the course of the following month, abscesses appeared in the left arm and the left leg. The patient was then taken home, but returned to a hospital 3 months later with swelling and pain in the left knee joint. This was aspirated and irrigated, with a prompt recovery. A transcript of the hospital record showed that the aspirated pus contained staphylococcus aureus in smear and culture.

April 25, 1931, the patient complained of pain in the right heel and the discharge from the sinus greatly increased and was slightly blood tinged. Three days later the left knee swelled and became somewhat painful. The swelling promptly subsided with very little further impairment of function. Examination at the present time shows a discharging sinus on the medial aspect of the right heel, scars on the lateral side of the lower third of the left humerus and the middle half of the outer surface of the left leg. There is slight limitation of motion in both the right elbow and left knee joints. Wassermann and Kahn examinations of both patient's and mother's blood were negative. Tuberculin (1:100) was negative. The X-ray films showed osteomyelitis of the right os calcis and the mid shaft of the left fibula, and a destructive arthritis of the left knee joint.

CASE 2. E. K., male, 4 years of age (Fig. 3). The patient was perfectly well until 2 years of age, when



Fig. 4. Case 3. Note destructive arthritis of the left hip joint with erosion at the points of greatest contact and pressure, also pathological dislocation of the right femur and osteomyelitis of the wing of the right ileum.

he was picked up from the sidewalk apparently delirious, with a fever and pain. Two days later the left leg swelled and the patient was taken to a hospital. The subsequent history was compatible with acute osteomyelitis involving several bones. Examination at the present time shows multiple scars of old sinuses over the left clavicle, right lumbar region, left fibula, right tibia, and distal right humerus. The right leg is $1\frac{1}{2}$ inches longer than the left, and there is some limitation of motion in both knee joints. The Wassermann, Kahn, and tuberculin tests were negative. The radiograms showed areas of osteosclerosis of the left clavicle, both iliac alæ, distal shaft of the right humerus, upper three-fourths of the right tibia, and middle third of the left fibula, and a destructive arthritis of both knee joints.

This case demonstrates multiple but presumably healed foci of osteomyelitis with involvement of two joints. The right knee displays extension from the adjacent diaphysis of the tibia, while the arthritic changes in the left knee joint appear to be the result of a hæmatogenous infection, for there is no evidence of a pre-existing osteomyelitis in the adjacent tibial and femoral diaphyses.

CASE 3. F. S., No. 22095, male, aged 11 years (Fig. 4), admitted to the hospital April 24, 1930, gave a history of very good health until the onset of the present illness in August, 1929. On the day



Fig. 1, left. Case 1. Minimal destructive joint changes with no involvement of adjacent diaphyses, old lesion of the shaft of the fibula. *Staphylococcus pus* aspirated from this joint.

Fig. 2. Case 1. The joint changes in the right knee are no doubt the result of direct extension from the extensively diseased tibia; those of the left knee joint probably are metastatic.

infections seldom proved to be metastatic. Almost invariably he was able eventually to demonstrate X-ray evidence of a primary lesion in the diaphysis. In accord with this, Wilensky (16) states that a bone lesion is always to be assumed in staphylococcus arthritis but that streptococcus or pneumococcus joint infections are as a rule unassociated with bone lesions.

In a review of 217 cases of acute and chronic osteomyelitis studied at the University of Chicago Clinics over a period of 43½ years, 9 cases presented evidence in their histories and physical and late X-ray examinations of pyogenic arthritis without evidence of osteomyelitis in the adjacent diaphyses, that is, 4.1 per cent. Of the 9 cases, 4 presented joint involvements which may have had their inception with the original blood stream invasion and accompanying showers of bacterial emboli and 5 developed late in the course of the disease presumably from secondary metastases from osteomyelitic foci. The joints involved were the temporomandibular in 3 cases, the hip, knee, and elbow each in 2 cases. These reports, based upon observations made during the end result stage of pyogenic arthritis, afford no statistical bacteriological data but

staphylococci were cultured from other foci in bone in 7 of the 9 cases.

Forty two cases (19.3 per cent) presented evidence of pyogenic arthritis by direct extension with involvement of 53 joints. Extension occurred from the femur in 23 cases, the tibia in 16, the ilium in 8, the humerus in 3, the tarsal bones in 2, and the carpal bones in 1 case. The joints involved with respect to the bones from which extension occurred are as follows:

	Instances
Knee (9 cases, 36 per cent)	
Distal end of femur	3
Proximal tibia	6
Hip (14 cases, 33.4 per cent)	
Proximal femur	
Ilium	4
Ankle (1 case, 2.6 per cent)	
Distal tibia	
Tarsal bones	
Sacro-iliac (4 cases, 7.5 per cent)—iliac	4
Shoulder (1 case, 2.8 per cent)—humerus	
Elbow (1 case, 2.0 per cent)—humerus	
Wrist (1 case, 2.0 per cent)—carpal bones	

(Of the entire series of 7 cases of osteomyelitis, the tarsal bones were involved in two instances, the carpal in only one. However, in all three cases the infection extended to the adjacent joints.)

Three cases presented joints involved both by direct extension and metastasis. In 9 cases of the entire series there was record or a



Fig 6 Case 8 Ankylosis of right hip joint with no involvement of adjacent bone. The left hip obviously infected by extension from the head, neck, and shaft of the left femur.

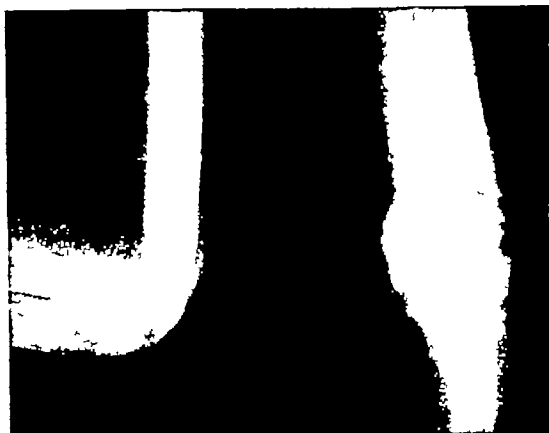


Fig 7 Case 9 There is a definite arthritis with some limitation of motion, a bulbous enlargement of the proximal extremity of the ulna.

The patient was admitted to the hospital at this observation for a secondary arthroplasty of the left temporomandibular joint. The result was very satisfactory.

CASE 6 L. B., No 17938, a white woman 33 years of age, admitted December 13, 1929, gave a history of osteomyelitis of the left tibia of 13 years' duration, coming on with a stormy onset 2 days after a puncture wound of the left great toe. Early drainage had been established and two subsequent operations upon the left tibia had been performed. For 6 months the patient had had pain in the left temporomandibular region, and difficulty in opening her mouth.

Examination revealed healed scars over the medial and lateral aspects of the lower two-thirds of the left tibia, considerable limitation of motion in the left knee, and ankylosis in the left ankle joint. Some limitation of motion and marked tenderness of the left temporomandibular joint were noted. The X-ray studies indicated an osteomyelitis of most of the shaft of the left tibia with a sequestrum and fusion to the fibula, ankylosis of the left ankle joint, and changes in the left femoral condyle, with no definite bone changes in the left temporomandibular joint. The Wassermann, Kahn, urine, and blood studies were negative.

Sequestrectomies of the left tibia were done December 21, 1929 and November 26, 1930. *Staphylococcus aureus* was found in smear and culture.

Cases 4, 5, and 6 present an added interest as a series of axioiding arthritis of the temporomandibular joint. All subsided without drainage.

CASE 7 R. C., No 1553 (Fig 5), a white boy of 5½ years, entered the hospital January 4, 1928,

with a history of osteomyelitis of 2½ years' duration, involving the left femur, the left tibia and ankle, the left humerus, the left ilium, and the right side of the skull.

Examination showed healed scars over the left elbow joint, the right lateral occipital region, the left lower leg and ankle, and a discharging sinus over the left hip. Roentgenograms revealed multiple healed or healing osteomyelitic foci of the skeleton, with an active process in the right humerus and an arthritis of the left elbow. The blood Wassermann, Kahn, urine, and tuberculin tests were negative.

Partial osteotomies were done on the right humerus and left ilium December 2, 1928. *Staphylococcus aureus* was found in smear and culture, and bone sections were reported to be osteomyelitic.

CASE 8 R. M. H., No 25661 (Fig 6), a girl of 10 years, admitted to the hospital August 25, 1930, reported good health until she suffered a puncture wound, 6 months before admission, in the right thigh, followed a few days later with a cellulitis and lymphangitis. This promptly healed and 2 weeks later she developed clinical evidence of a bacteriæmia but had negative blood cultures. In the course of the next few weeks there developed a pleurisy, superficial abscesses, and osteomyelitic foci in the right first metatarsus, the upper one-third of the right tibia, the lower one-third of the right radius, the upper one-third of the right humerus, and the upper thirds of the left humerus and left tibia. All foci were drained apparently by simple incision of the overlying soft tissues. Five months after the onset of the present illness and 2 weeks before admission, the right hip became painful and tender for the first time and was associated with fever and ill feeling.

The examination revealed a granulating sinus at the base of the right great toe, and tender enlarge-



Fig. 5. Case 4 (Illustrative of Cases 5 and 6.) Note obliteration of the joint space of the right temporomandibular joint. Its outlines can scarcely be made out.

following an injury received while swimming he suddenly developed a chill, severe pain in the right hand and left leg and foot. Swelling and redness of the leg rapidly followed, and 10 days later both hips became painful. Three months after the onset, spontaneous drainage of thick, yellow pus occurred over the left great toe, and a few weeks later the same occurred in the left leg. There was a history of frequent attacks of tonsillitis. On April 26, 1930 partial osteotomies of the lower third of the left tibia and interphalangeal joint of the left great toe were done. The pathological report was pyogenic osteomyelitis and the cultures yielded *staphylococcus aureus*. The Wassermann, Kahn, tuberculin, and urine tests were negative.

The present physical examination shows a discharging sinus of the medial aspect of the lower third of the left leg, and scars on the dorsum of the great toe and lower third of the right humerus. The left ankle is ankylosed with 15 degrees plantar flexion, the right leg in 45 degrees abduction and 50 degrees external rotation. The X-ray films show osteomyelitis of the ala of the right ilium and the lower third of the left tibia, with bony ankylosis of the adjacent tibio-tarsal joint, and osteoarthritis of the left knee, left shoulder, and both hip joints. The head of the right femur is dislocated upward with erosion of the acetabulum and femoral head.

Of special interest in this case are the X-ray evidences of bone destruction of the femoral head and the rim of the acetabulum at the points of greatest contact and pressure in the joint (Phemister 16).

CASE 4. R. J. No. 56877 (Fig. 5) a white male aged 18 years admitted August 6, 1930, gave a history of an injury over the right tibia 3 1/2 years before admission followed by a painful swelling and 3 months later spontaneous drainage. Then swelling and likewise spontaneous drainage occurred at the

left elbow, left middle finger and over the left scapula. All foci promptly healed with the exception of that in the tibia. He had pain in the right temporomandibular joint during the acute illness and about 6 months later noticed a gradual progressive blocking of his jaw with pain and swelling.

The physical examination was negative except for scars over the sites noted and a spindle shaped enlargement of the right tibia with a long suppurating sinus and ankylosis of the right temporomandibular joint. The routine laboratory studies of the urine and blood, the Wassermann, Kahn and tuberculin tests were negative. The X-ray examination showed evidence of an old sclerosing osteomyelitis of the upper half of the right tibia, osteomyelitis with cavitation of the mid-shaft of the left humerus, and an ankylosing arthritis of the right temporomandibular joint with obliteration of the joint space.

August 26, 1930, an arthroplasty was done on the right temporomandibular joint. Bone removed at subsequent operations on the right tibia and left humerus was reported to present the pathology of osteomyelitis, and *staphylococcus aureus* was shown in smear and culture. Eleven months after the arthroplasty the mouth could be opened normally.

CASE 5. C. B. No. 61 a white male of 21 years, admitted October 3, 1927 gave a history of onset of osteomyelitis 6 years previously, with delirium, and involvement of the left femur, right tibia, left scapula, left and right metatarsus, left tibia, right ischium, right fibula, right sinus and right humerus, in rapid succession. These foci were all drained and the *staphylococcus aureus haemolyticus* was cultured from them. Soon afterward pain and swelling developed in front of both ears and both jaws gradually became ankylosed. Arthroplasties were done on both joints. During the first 3 years of this illness the boy had repeated small hemoptyses, and a diagnosis of pulmonary tuberculosis was made and verified by the presence of tubercle bacilli in the sputum. The blood Wassermann Kahn, and urine tests were negative.



Fig 6 Case 8 Ankylosis of right hip joint with no involvement of adjacent bone The left hip obviously infected by extension from the head, neck, and shaft of the left femur



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Examination revealed healed scars over the medial and lateral aspects of the lower two-thirds of the left tibia, considerable limitation of motion in the left knee, and ankylosis in the left ankle joint Some limitation of motion and marked tenderness of the left temporomandibular joint were noted The X-ray studies indicated an osteomyelitis of most of the shaft of the left tibia with a sequestrum and fusion to the fibula, ankylosis of the left ankle joint, and changes in the left femoral condyle, with no definite bone changes in the left temporomandibular joint The Wassermann, Kahn, urine, and blood studies were negative

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with a history of osteomyelitis of 2½ years' duration, involving the left femur, the left tibia and ankle, the left humerus, the left ilium, and the right side of the skull

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CASE 4. R. J., No. 26877 (Fig. 5) a white male aged 18 years, admitted August 10, 1930, gave a history of an injury over the right tibia 3½ years before admission, followed by painful swelling and 3 months later spontaneous drainage. Then swelling and like the spontaneous drainage occurred at the

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The physical examination was negative except for scars over the sites noted and a spindle shaped enlargement of the right tibia with a long suppurating sinus and ankylosis of the right temporomandibular joint. The routine laboratory studies of the urine and blood, the Wassermann, Kahn, and tuberculin tests were negative. The X-ray examination showed evidence of an old sclerosing osteomyelitis of the upper half of the right tibia, osteomyelitis with cavitation of the mid-shaft of the right humerus, and an ankylosing arthritis of the right temporomandibular joint with obliteration of the joint space.

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CLINICAL SURGERY

FROM ST LUKE'S HOSPITAL, KANSAS CITY

THE SHELF OPERATION IN THE TREATMENT OF CONGENITAL DISLOCATION OF THE HIP

FRANK D. DICKSON, M.D., F.A.C.S., KANSAS CITY, MISSOURI

GENERALLY speaking, in the treatment of congenital dislocation of the hip, two methods are employed, reduction by closed manipulation, reduction by operation. Actually, however, there is a third method of treatment which must be used at times which cannot be included under the term "reduction" since it does not attempt replacement of the dislocation but has for its object the relief of symptoms and improvement in function in a dislocated hip which cannot be reduced. Reduction by manipulation is, at the present time, fairly well standardized, at least it may be said that the basic principles of the manipulative method have been established and most of the methods in common use conform to these principles. The technique of reduction by operation was established by Galloway, in 1920, and this technique, with such modifications as the individual operator may have chosen to make, is generally used today. For the treatment of congenital dislocation of the hip in those cases in which it is impossible actually to reduce the dislocation, a variety of procedures have been devised. One of these procedures, the shelf operation, it is proposed to discuss in this contribution.

In the management of congenital dislocation of the hip the factor which most profoundly influences the course to be followed is the age of the affected individual. Age is of paramount importance because it not only determines when closed reduction should be abandoned and reduction by operation resorted to, but also what type of operative procedure is to be employed. It is, then, impossible intelligently to discuss any form of treatment for congenital dislocation of the hip without taking into consideration the age factor, and a brief discussion of the way in which age influences the selection of the method of treatment used becomes a necessary preliminary to a discussion of a specific form of treatment such as the shelf operation.

For the purpose of this discussion we will separate cases of congenital dislocation of the hip into three age groups. These groups represent approximately the important age periods in so far as treatment is involved. These groups are:

Group I. Patients up to 4 years of age.

Group II. Patients from 4 to 9 years of age.

Group III. Patients over 9 years of age.

In using the age periods shown in these three groups we recognize that no sharp lines of demarcation can be drawn, they are meant to be an approximate guide, not an absolute one. Our experience, however, leads us to believe that these groups truly represent definite dividing lines in the treatment of congenital dislocation of the hip.

Group I. This group may be briefly dismissed with the statement that practically every congenital dislocation of the hip in patients up to the age of 4 years can be successfully reduced by one of the methods of closed manipulation in use. Occasionally, however, closed reduction within this age limit is impossible and reduction by the open method must be resorted to. In our clinic open reduction in patients under the age of 4 years has been necessary in only 2 cases in 10 years.

Group II. In Group II we enter upon debatable ground. Many experienced orthopedic surgeons hold that the closed method of reduction should be used in children up to the age of 7 years and even up to 10 years. Others are convinced that closed reduction should be abandoned when a child has reached the age of 4 years and the open method of reduction used. Galloway, with a wide and successful experience, advocates reduction by operation at $2\frac{1}{2}$ years and considers 20 months to be the ideal age for this method. Experience over the past 12 years, during which time 71 congenital dislocations of the hip have been treated, has convinced us that, in our hands at least, the best results are secured by reducing all dislocated hips over the age of 4 years by the open method.

ments over the upper ends of both tibiae and both humeri, and the lower one-third of the right radius. The right hip was fixed in flexion with limitation of and pain in, all motions there was also tenderness over the greater trochanter. The laboratory studies, including blood Wassermann, urine, blood, and tuberculin, were negative except for evidence of a moderate anemia. Roentgenology demonstrated osteomyelitis of both humeri, both tibiae: first right metatarsus, and the right radius, and a pyogenic arthritis of the right hip joint.

Partial osteotomies were done on both tibiae, both humeri, the right radius, and the right first metatarsus. Microscopic sections revealed chronic osteomyelitis. The right hip was never drained and subsided with ankylosis.

CASE 9 L. H., No. 7964 (Fig. 7) a white male aged 14 years, entered the hospital November 13, 1928, with a history of osteomyelitis of the left femur right fibula, and sacrum of 3½ years' duration apparently not coming on abruptly.

Examination showed marked cardiac hypertrophy with decompensation, marked enlargement of the liver and spleen, and draining sinuses over the right fibula and left hip. The left elbow and left shoulder were greatly limited in motion. The roentgenograms showed arthritic changes in the left elbow osteomyelitis of the proximal end of the left humerus with involvement of the shoulder joint, the wing of the left ilium, the left femur with destruction of the entire head and neck, and the right fibula with absence of most of its shaft. The urine consistently contained a large quantity of albumin with an occasional granular cast. The haemoglobin was 65 per cent, the red blood count 4,800,000, the blood Wassermann and Kahn negative. 100 per cent of Congo red, injected intravenously was absorbed.

The patient was discharged with a diagnosis of chronic suppurative osteomyelitis with multiple foci and amyloid degeneration of the liver and spleen.

SUMMARY

1. Of 217 cases of pyogenic osteomyelitis there was associated arthritis in 51 cases, an incidence of 23.5 per cent.

2. Of these 51 cases, 42 (19.3 per cent) arose by direct extension from an adjacent diaphyseal infection. The large weight bearing joints constituted 92.5 per cent of this group.

3. In 9 cases (4.1 per cent) the joints appeared to have become involved by blood borne infections, presumably from remote foci of osteomyelitis. However there may have

existed at some time a small undiscovered lesion in the adjacent bone, and the joints may represent the end-result of an abortive osteomyelitis.

4. The seriousness of this complication of osteomyelitis has been measured in this analysis by the end-results of the joint damage alone. Only 13.2 per cent of joints infected by direct extension regained a good range of motion, 65.2 per cent became ankylosed, and the remaining 22.6 per cent suffered varying degrees of functional limitation.

A comparison of these end-results with those resulting from hematogenous infection, in the small series analyzed suggests that less joint damage is produced by the latter type. In this group ankylosis occurred in 44.5 per cent and a good range of motion was preserved in 33.3 per cent of the cases.

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THE SHELF OPERATION IN THE TREATMENT OF CONGENITAL DISLOCATION OF THE HIP

FRANK D. DICKSON, M.D., F.A.C.S., KANSAS CITY, MISSOURI

GENERALLY speaking, in the treatment of congenital dislocation of the hip, two methods are employed, reduction by closed manipulation, reduction by operation. Actually, however, there is a third method of treatment which must be used at times which cannot be included under the term "reduction" since it does not attempt replacement of the dislocation but has for its object the relief of symptoms and improvement in function in a dislocated hip which cannot be reduced. Reduction by manipulation is, at the present time, fairly well standardized, at least it may be said that the basic principles of the manipulative method have been established and most of the methods in common use conform to these principles. The technique of reduction by operation was established by Galloway, in 1920, and this technique, with such modifications as the individual operator may have chosen to make, is generally used today. For the treatment of congenital dislocation of the hip in those cases in which it is impossible actually to reduce the dislocation, a variety of procedures have been devised. One of these procedures, the shelf operation, it is proposed to discuss in this contribution.

In the management of congenital dislocation of the hip the factor which most profoundly influences the course to be followed is the age of the affected individual. Age is of paramount importance because it not only determines when closed reduction should be abandoned and reduction by operation resorted to, but also what type of operative procedure is to be employed. It is, then, impossible intelligently to discuss any form of treatment for congenital dislocation of the hip without taking into consideration the age factor, and a brief discussion of the way in which age influences the selection of the method of treatment used becomes a necessary preliminary to a discussion of a specific form of treatment such as the shelf operation.

For the purpose of this discussion we will separate cases of congenital dislocation of the hip into three age groups. These groups represent approximately the important age periods in so far as treatment is involved. These groups are:

Group I. Patients up to 4 years of age.

Group II. Patients from 4 to 9 years of age.

Group III. Patients over 9 years of age.

In using the age periods shown in these three groups we recognize that no sharp lines of demarcation can be drawn, they are meant to be an approximate guide, not an absolute one. Our experience, however, leads us to believe that these groups truly represent definite dividing lines in the treatment of congenital dislocation of the hip.

Group I. This group may be briefly dismissed with the statement that practically every congenital dislocation of the hip in patients up to the age of 4 years can be successfully reduced by one of the methods of closed manipulation in use. Occasionally, however, closed reduction within this age limit is impossible and reduction by the open method must be resorted to. In our clinic open reduction in patients under the age of 4 years has been necessary in only 2 cases in 10 years.

Group II. In Group II we enter upon debatable ground. Many experienced orthopedic surgeons hold that the closed method of reduction should be used in children up to the age of 7 years and even up to 10 years. Others are convinced that closed reduction should be abandoned when a child has reached the age of 4 years and the open method of reduction used. Galloway, with a wide and successful experience, advocates reduction by operation at $2\frac{1}{2}$ years and considers 20 months to be the ideal age for this method. Experience over the past 12 years, during which time 71 congenital dislocations of the hip have been treated, has convinced us that, in our hands at least, the best results are secured by reducing all dislocated hips over the age of 4 years by the open method.



Fig. Position on operating table patient turned slightly toward non-operative side.

However, whether reduction by operation is used in patients at the age of 4 years, or earlier or later it is possible, by the open method, in the majority of patients up to the age of 9 years to return the head of the femur to the acetabulum, and the result should be a physiological cure. As stated previously the technique of Galloway is entirely satisfactory for open reduction in this age group.

Group III. After the age of 9 to 12 years, we believe, the picture of congenital dislocation of the hip changes rather suddenly. Up to this age, as has been pointed out, the dislocated femoral head can in the majority of cases be restored to the acetabulum by either the closed or open method in children over 9 years of age such reduction is generally impossible or if possible, undesirable. Reduction is impossible because the thickened and contracted capsule and the extreme shortening of the muscles which pass from the pelvis across the hip joint to the femur prevent, except by using extreme force and running unjustifiable risks, the displacement of the head downward sufficiently to allow it to enter the acetabulum. Reduction is undesirable in these cases because, even if the reduction can be accomplished by the use of great force, the head is thrust so strongly against the acetabulum by the contracted structures about the hip joint that absorption of the articular cartilage follows and rigidity or complete ankylosis will result in a very high percentage of the cases. Ankylosis, or even marked limitation of motion, is a very disabling condition and the strong probability that it will occur constitutes a definite contra-indication to replacing the femoral head in the acetabulum in these older cases. Our problem in Group III then is quite different than in Groups I and II and our treatment must in the majority of cases aim at stabilizing the hip and improving the function of the joint without restitution of the dislocated

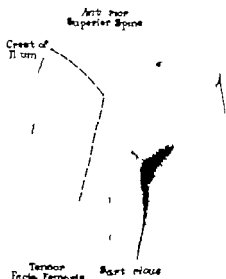


Fig. 2. The Smith-Petersen incision.

head. We must, in other words, abandon the ideal of a physiological cure, possible in Groups I and II and be satisfied with what Kreuz, of Berlin, has termed a pathophysiological cure.

Efforts to devise a satisfactory method of stabilizing a congenitally dislocated hip and at the same time preserve a useful amount of motion without restoring the dislocated head to the acetabulum have produced a variety of operative procedures. These include the methods of Allston and Swett which attempt to restore the head to the acetabulum, even in older patients, by a two stage operation the Lorenz, von Baeyer and Kurmason bifurcation operations the Sharr osteotomy and the shelf operation. The last of these, the shelf operation, has been used routinely in our clinic for the past 12 years, and it is the technique of this operation we propose to discuss in detail.

The shelf operation for congenital dislocation of the hip aims (1) to improve the weight bearing position of the head of the femur by bringing it forward from its position on the posterior plane of the pelvis to a position on the ridge between the anterior and posterior planes or onto the anterior plane itself thus overcoming lordosis (2) to stabilize the dislocated hip for weight bearing purposes (3) to preserve a useful amount of pain free motion in the hip. To accomplish these three cardinal purposes we believe that a definite technique is necessary the procedure as carried out in our clinic has varied but little from that

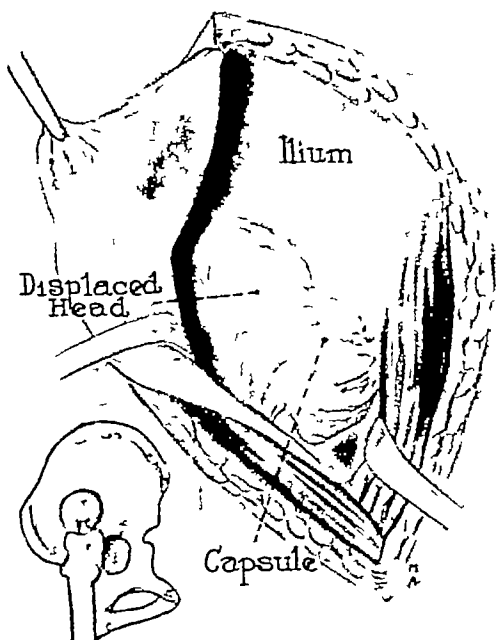


Fig 3 The incision has been deepened to expose the capsule and displaced head lying in the posterior plane of the pelvis above and posterior to the true acetabulum.

described by the author in the *Journal of Bone and Joint Surgery* of 1924, and is as follows

TECHNIQUE

Preliminary preparations Skeletal traction is applied for 2 weeks by means of a Kirchner wire passed through the crest of the tibia just below the tuberosity. Notwithstanding the assertion frequently made that little relaxation of contracted structures may be expected from traction preliminary to operation for congenital dislocation of the hip, experience has convinced us that when skeletal traction is used a definite amount of relaxation is secured and that the dislocated head can be much more easily displaced at operation than in these cases in which such preliminary traction is not used. From 10 to 15 pounds of weight are used, depending upon the age and physical condition of the patient.

Operative preparation The operative field prepared extends from the umbilicus to the knee on the side to be operated upon and includes half of the pelvis and the entire thigh. A double preparation is given, one at noon of the day before the operation and the second in the late afternoon. On the operating table the entire area is painted with a 2 per cent iodine solution. The pubic hair, if present, is shaved.

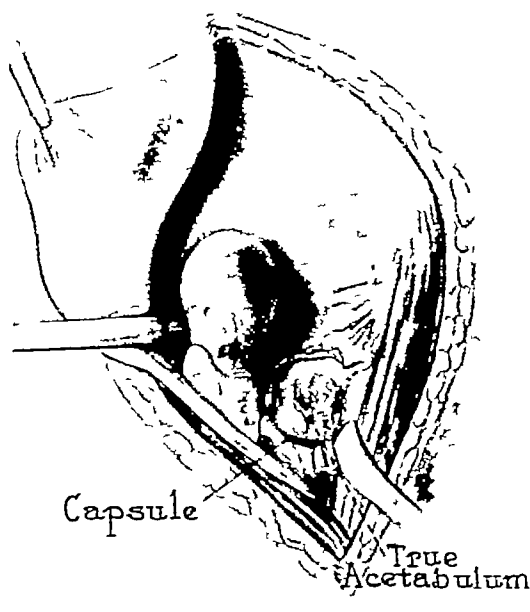


Fig 4 The capsule has been cut away and all restricting structures divided or stripped back, and the head is completely free. The lever is in position to slide the head forward onto the ridge between the anterior and posterior planes of the pelvis or onto the anterior plane.

Placement on the operating table (Fig 1) Some form of traction operating table must be used. The patient is placed upon the table with traction applied to both legs, the traction already in place (Kirchner wire) is used on the side to be operated upon and skin traction is used on the opposite leg to secure countertraction and to anchor the pelvis. Only sufficient traction is applied to hold the patient on the pelvic support, thus allows the patient to be rolled slightly toward the side not to be operated upon and affords better access to the region to be operated upon.

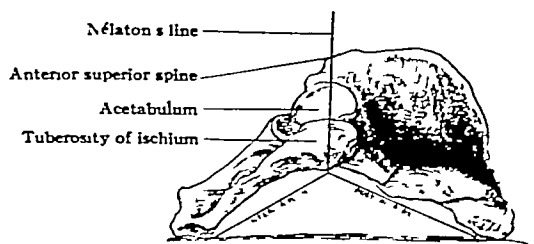


Fig 5 The anterior and posterior planes of the pelvis are shown with ridge between (From Davis' *Applied Anatomy*)

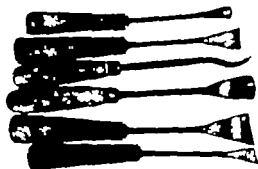


Fig. 6. Woodcutter's gouges of various sizes.

The steps of the operation are as follows:

1. The Smith-Petersen incision, which runs from well back on the iliac crest down onto the thigh, is used (Fig. 2). This incision is the only one which gives sufficient exposure to allow the subsequent steps of the operation to be carried out efficiently. The skin edges are protected by towels fastened with tetra clamps. The incision is deepened in the usual manner until the capsule of the joint is reached and freely exposed (Fig. 3).

2. The dislocated head is now completely freed of all structures which interfere with complete mobility. This is accomplished by freely and completely cutting away all the thickened capsule and by dividing all fibrous bands. Muscle attachments which interfere, particularly those to the greater trochanter, are preserved as far as possible by stripping up their periosteal attachments. Generally it is necessary to divide the tendon of the ilopsoas which is usually markedly shortened; no ill effects have followed this. The importance of completely freeing the upper end of the femur cannot be overemphasized; attempts to preserve the capsule prevent this and are unnecessary as it regenerates later (Fig. 4).

3. The head, neck, and upper part of the greater trochanter having been completely freed, traction on both legs is gradually increased. As the traction force acts, the elevated side of the pelvis is allowed gradually to sink until the patient is lying flat on the table. At this point a lever (Fig. 4) is placed behind the head and neck and if the upper end of the femur has been adequately freed, the head readily slips forward onto the ridge between the posterior and anterior planes of the pelvis (Fig. 5) into a position above or above and slightly in front of the acetabulum. Traction is then gradually increased until the head has been pulled down in its anterior position



Fig. 7. Flap is turned down coming well down both anteriorly and posteriorly and covering the femoral head like a cap.

to a point beyond which it will not descend without the use of unjustifiable force; this is as a rule about an inch to an inch and a half. Both lower extremities are then gradually abducted and the traction is tightened to take up the slack which usually follows this maneuver. The head is now in the position in which, by turning down a flap or shelf of bone from the side of the ilium, it is to be held permanently.

4. The shelf is formed as follows. A wood-cutter's gouge (Fig. 6) the size depending upon the size of the shelf to be formed, is used to turn down a flap of bone from the side of the ilium. This flap should be 1.5 to 2 inches in depth and at least 0.5 inch thick at its base. The flap should start well anterior to the head and be continued over it and well down posteriorly so that when the shelf is completed it fits over the upper part of the head like a cap (Fig. 7). It should be understood that the shelf turned down is not merely a ledge of bone projecting from the ilium but a modelled covering for the femoral head. A large wedge of bone is then removed from the crest of the ilium, or several wedges if so desired, and this is securely fixed between the turned-

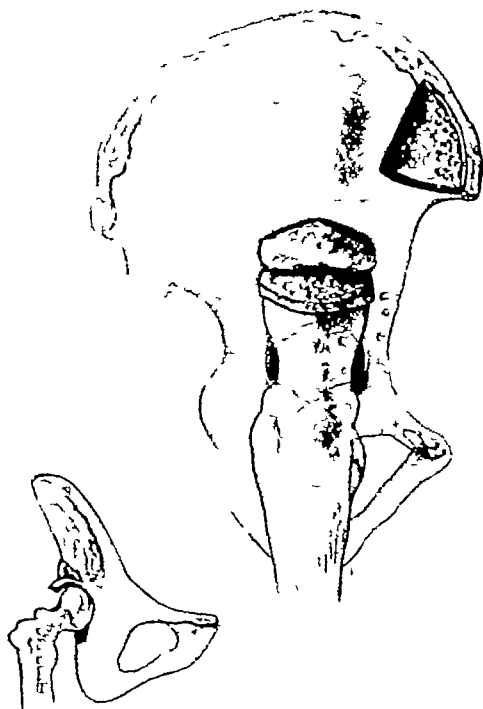


Fig 8 Wedge of bone has been removed from the crest of the ilium and fixed between the side of the ilium and the turned down flap

down shelf of bone and the side of the ilium, filling the space between them (Fig 8). The wedge of bone acts as a brace for the turned down flap and provides a firm shelf above the head capable of resisting a fairly strong upward thrust without giving way.

5 At this point the condition of the adductor tendons of the thigh is examined, if they are under tension, an assistant does an open tenotomy of these tendons before closure of the wound is commenced.

6 Closure of the wound is made in the usual manner by layers. Drainage is rarely used and, if used, consists of a piece of rubber dam placed just under the skin and removed in 12 hours.

7 A plaster-of-Paris cast is now applied to include both hips and to extend down to just below the knee on the side which has been operated upon. The patient is transferred directly to bed from the operating table, strong traction on the extremity operated upon being maintained constantly by an assistant during this transfer and until the traction apparatus attached to the bed has been arranged and is acting.



Fig 9 Roentgenogram showing type of shelf secured

After-treatment Traction is maintained constantly for 6 weeks. At the end of the fourth week, the cast is bivalved and mild flexion and rotation movements are given daily. After 6 weeks traction is discontinued and physiotherapy continued with gradually increasing range of motion insisted upon. Weight bearing is started at the end of 6 weeks with crutches and at the end of 8 weeks unrestricted weight bearing is permitted. It is necessary to maintain supervised exercises for several months following operation in order to secure full range of motion.

RESULTS

The results to be expected from a properly performed shelf operation are

- 1 A stable, pain free, freely movable hip, with limitation of motion only in the extremes of the arc.
- 2 Improved weight bearing with improvement or disappearance of lordosis and its accompanying symptoms of backache.
- 3 A definite decrease in the shortening which, on the average, is about 1 inch.
- 4 Improved walking because of the resulting stability and lessening of the gait in the hip on weight bearing.

We have performed the shelf operation in 26 dislocated hips with the following results:

	Cases	Per cent
Good results		80.7
Improved	1	7.6
Failures	1	3

The youngest patient operated on was 9 years old, the oldest 40 years old.

The failures were due in one case to a low-grade infection which resulted in ankylosis but with improvement in position. The second failure was not one of failure to secure stability and motion but, since the operation, the patient has suffered from very marked symptoms in the sacro-iliac joint on the side operated upon. The third failure was due to an attempt to secure too much length with resulting pressure on the head with absorption of articular cartilage and rigidity in the hip.

There have been no deaths in the 26 cases operated upon nor have any serious complications occurred. Unduly prolonging the operation and attempting to obtain too much lengthening should be avoided as they tend to cause shock.

The results of the shelf operation, so far as we can determine, have been lasting. Four patients

were operated upon 12 years ago and all are leading active lives without symptoms or any interference with active use of the hip. The same results are being obtained in more recent cases, as shown in Figure 9.

CONCLUSIONS

In conclusion, may I say that it is my firm belief that before many years have passed the question as to what is the best operative procedure for neglected cases of congenital dislocation of the hip will rarely come up for decision because, as the public and profession become educated, practically all cases will fall in Groups I or II when physiological cure is possible. It is in the first 3 years of life that congenital dislocation of the hip must be treated if it is to be cured completely so that the most important step in the management of congenital dislocation of the hip, as I see it, is the untiring preaching of the gospel of early diagnosis and early correction. The various operations for treatment of the long standing, or perhaps better the neglected cases, are makeshift procedures which, it is true, fulfill a definite purpose but they by their very existence constitute a reproach to the medical profession.

FROM THE SURGICAL CLINIC, UNIVERSITY OF FRANKFURT A MAIN

WIRE EXTENSION TREATMENT OF FRACTURES OF FINGERS AND METACARPAL BONES

DR MED HANS MELTZER, FRANKFURT A MAIN, GERMANY

Assistant in the Surgical Clinic University of Frankfurt a Main Professor V Schmieden Director

THERE are three points of importance to be kept in mind in treating fractures of the fingers and metacarpal bones (1) The ends of the fragments must be brought into a position which is absolutely faultless anatomically (2) Fractures of the fingers and metacarpals are especially apt to result in great dislocations and for this reason the correct position of the fragments should be judiciously maintained until the formation of callus prevents the fragments from being dislocated and shoved against one another (3) Physical therapy must be begun as early as possible, lest the wrist and the joints of the fingers grow stiff Usually it is not so difficult to obtain an exact reposition of the fragments as it is to keep them in position and, without again dislocating the fragments, to start exercises early The contraction produced by the tendons and aponeuroses works to a disadvantage upon the maintenance of the fixation of the fracture, and may prove to be a real danger when physical therapy, which is absolutely necessary, is begun early We know that fingers and wrists, especially, grow stiff very quickly when they are held in a fixed position It is always a question whether the patient will be able to make use of his hand in a normal way after it has been kept at rest for some time or whether he will be incapacitated economically as well as psychologically In a study by Ziegler of a series of 403 cases of fractures of the fingers, the percentage of invalidism was found to be an average of 24.9 per cent

The two problems, the maintenance of fixation and early orthopedic treatment, have brought forth many therapeutic proposals In a recent, more detailed contribution¹ I suggested that the methods hitherto proposed had certain disadvantages which led to disappointing results The various types of splints for the hand and the fingers do not prevent new dislocations of fragments after they have been well and properly aligned The method of fixing the hand with fingers closed over a roll of gauze has the same disadvantages, moreover, the fingers which are not involved are fixed as well The method of

extending the parts by means of adhesive plaster is not only very disagreeable to the patient but the wrist and the joints of the fingers are stretched in a way not physiological, and the result is again disappointing This method, too, has still another disadvantage in that in certain cases sufficient pressure cannot be procured from the adhesive plaster without exposing the tip of the finger to the danger of being insufficiently nourished Without entering into particulars I would refer to my contribution just mentioned

I have tried to overcome all of the disadvantages referred to by making an apparatus for extension of the finger by means of wire The chief points of interest are as follows

1 The apparatus should make it possible to exert traction strong or mild according to the conditions met in a given case

2 The finger which is to be extended and the wrist which is to be fixed should be brought into a physiological position which is agreeable to the patient and which will facilitate and shorten the period of treatment to restore function

3 It is absolutely necessary that while fixed and extended by means of the apparatus the finger affected as well as the other fingers can be exercised in order to provide against the danger of stiffness

4 It is essential that the apparatus be so constructed that it can be used to extend each finger and to take the place of the cuff of plaster of Paris used on the forearm, the application of which requires much time

On the basis of these postulates and after having been tried thoroughly, the apparatus is now made (by Braun-Melsungen) as shown in Figures 1 to 5² It may be described briefly as follows

There is a forearm cuff made of neat leather which is adjustable to different size wrists By three straps a narrow Kramer splint is fixed in such a manner that its form and direction may be altered according to the kind and the situation of the fracture By means of a spiral spring at

¹Chir., 1932, p. 58

²The apparatus can be obtained from the American Medical Specialties Co. Inc. 357 Seventh Avenue New York.



Fig. Finger extension and how to produce traction.

the end of the Kramer splint there is applied for extension a light and narrow bow holding a thin steel wire which is rust proof according to Kirschner. The bow produces traction as strong as necessary for the fracture. Held in place by a leather strip there is also applied through the forearm cuff a prop made of aluminum which is bent to fit the hollow of the hand. This prop produces light and comfortable dorsiflexion—the only physiological position of the wrist—whereas the fingers are slightly flexed.

The Kirschner wire is laid diagonally either across the basal phalanx of the finger to be extended in case of fracture of the metacarpal bones, or across the middle phalanx in case of fracture of the basal phalanx. We can report but the best results from the minor surgical operation which can be carefully carried out under local or nerve block anesthesia without injury to any tendons, nerves, or arteries and without the danger of infection.

First the cuff softly padded, the Kirschner wire, and the bow extension are put on. Then the fragments are placed in position after 3 per cent novocain has been injected into the hema-

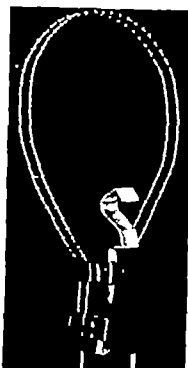


Fig. 2. Forearm cuff of leather with Kramer splint and aluminum prop which is bent to fit the hollow of the hand.

toma to overcome pain. Now the wrist is slightly dorsiflexed and the fingers less so. After a few hours, the patient will be able to move the extended finger a little. The bandage is kept on for 3 or 4 weeks, which time is necessary for the consolidation of the fracture so that redislocation is made impossible. Then the usual treatment is followed—the application of warmth and massage and exercise of the hand and fingers.

By means of wire extension excellent results have been obtained during the past two years at the Surgical Clinic of the University of Frankfurt a. Main. With this method even extremely badly dislocated fractures which have been treated by other means without success are cured. The results have been very favorable from an anatomical as well as a functional point of view. In all the cases mentioned the time required for physical therapy has been considerably lessened compared with the time required, for instance, when the method of extension by adhesive plaster was used. As to the patient himself this method is much more agreeable than are other ones, for it has the advantage of allowing a comfortable physiological position of the

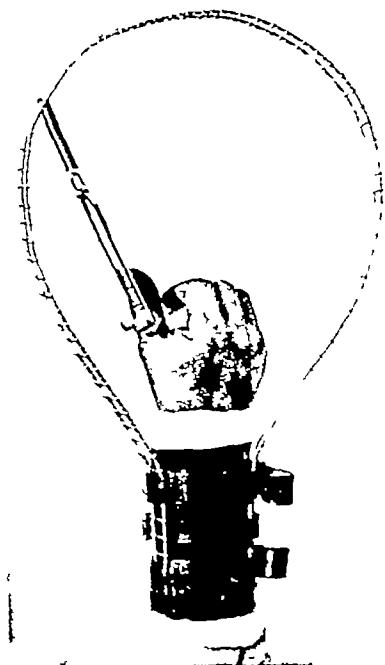


Fig 3

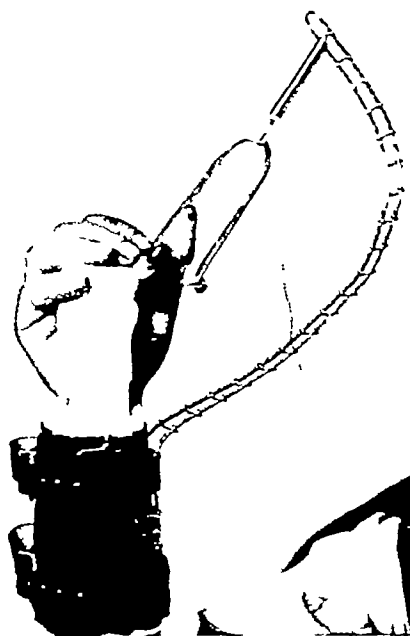


Fig 4

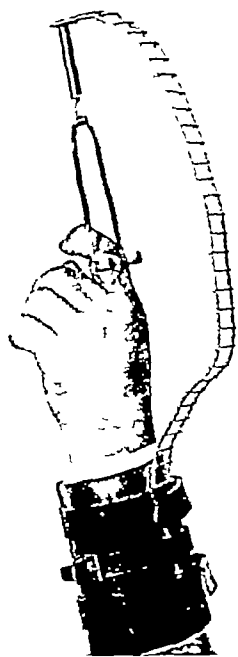


Fig 5

Fig 3 Finger extension applied Tennis racket form
 Fig 4 Finger extension applied Abduction position
 of the Kramer splint.

Fig 5 Finger extension applied Bayonet form of
 Kramer splint

wrist and the joints without the patient being constantly reminded of his disability

We believe that the postulates mentioned have been met by the wire extension apparatus and that this method may be recommended

SUMMARY

An apparatus is described for the treatment of fractures of the fingers and metacarpal bones. The apparatus is based on the principle of wire

extension. The apparatus permits more or less strong traction, bringing fingers and wrist into a comfortable middle position. The apparatus makes possible the correction and maintenance of exact reposition even in fractures with greatly dislocated fragments. The joints of the fingers can be moved without any pain immediately after the apparatus is applied—a means of facilitating the treatment afterward and a means of improving the results.

PANCREATIC LITHIASIS¹

F. D. ACKMAN, M.D. MONTREAL, CANADA
 Junior Assistant in Surgery, The Montreal General Hospital

ALBERT ROSS, M.D. MONTREAL, CANADA
 Associate Surgeon, The Montreal General Hospital

SINCE the condition of pancreatic lithiasis was first described by Graaf in 1667 relatively few cases have been recorded. The rarity of the condition is evidenced by the fact that a careful search of the literature reveals only 107 cases. Opie in 1910 found two cases in 1,500 autopsies at The Johns Hopkins Hospital.

It is probable that many cases are overlooked clinically because of the great difficulty in recognizing the condition even with modern methods of investigation. This is well illustrated in the case about to be described. Furthermore it has been recorded that stones have been missed at operation even when suspected and found at autopsy.

The literature on pancreatic lithiasis has been well reviewed from time to time. Over in 1900 collected 70 cases, and 4 years later Lazarus reviewed a total of 80 cases. In 1925 Seeger in a comprehensive review brought the total reported cases up to 101 including 1 case of his own. He emphasized the value of surgical treatment. Since Seeger's article appeared, reports of 6 more cases have been found: 4 by Hartmann in 1925, 1 by Charvat and Feklova, in 1926 and 1 case by Lindsay in 1929. The case about to be described brings the total up to 108. It is significant that, whereas almost all of the cases recorded up until the first of this century were autopsy findings, the greater number reported since have been operated on with for the most part, good results.

We have studied all of the previously recorded cases, but as the details of the earlier ones are scanty it seems advisable to confine our analysis to the 54 cases reported since the middle of the last century which are more complete. In analyzing these striking differences between the group operated upon and the group of postmortem cases were noted in both symptoms and findings. For the sake of comparison therefore, statistics of these two groups are presented separately. It will be noted, for example that whereas the average age in the postmortem series was 50 years, that in the surgical series was only 40 years. Of the entire 54 cases, 29 were surgical and 25 were reported as autopsy findings (Tables I and II).

Lindsay stresses the fact that both dull and colic-like pain are frequently present and that dull epigastric ache precedes the colic.

It will be seen from Tables I and II that epigastric pain of the colic-like type and less frequently, epigastric pain dull in character is the predominating symptom. The radiation of the pain is variable. While in the majority of cases it is referred to the back, there is here no constant site of radiation generally it is to one or other scapular region. In some cases, radiation as high as the shoulders has been noted in others as low as the lumbar region. A number of writers, notably Seeger have stressed left lumbar radiation. That this is characteristic, however can hardly be accepted. Nausea and vomiting occur frequently in association with the paroxysms of pain.

Of greater importance than pain, from a diagnostic standpoint is the frequent occurrence of

TABLE I—SURGICAL CASES

Number of cases reported	(1 per cent)	20
Average age		40
Sex		
Males		10
Females		17
Not mentioned		
Symptoms and Signs		
Pain		
Dull epigastric		1
Colic-like epigastric		10
Constant		
Referred to thoracic region of back		8
Referred to left lumbar region		
Referred to back lumbar region		
Radiating down arm (left)		
Radiating into umbilicus		
Nausea and vomiting with attacks of pain		
Anorexia (always late)		4
Constipation with attacks		6
Diarrhea with colic		
Bleeds in the stool		
Marked loss of weight		10
Irregular micturitions of stone		
Follicular fever		
History of duodenal ulcer		
X-ray findings		
Positive pre-operative		
Positive postoperative		
Negative		
Findings		
Calculi		
Multiple		1
Single		6
Cysts of pancreas		
Abscess of pancreas		
Fat necrosis of pancreas		
Lacerations of the pancreas		
Associated Findings		
Duodenal ulcers		2
Gall stones		
Results		
Immediate recovery		17
Postoperative death		
	(4.6 per cent)	
	(7.4 per cent)	

From the Department of Pathology, The Montreal General Hospital, and The St. Anne Military Hospital

steatorrhœa and diarrhœa. The occurrence of steatorrhœa and the rare finding of typical calculi in the stools, emphasize the importance of a careful examination of the fœces. Kinnicut, in 1903, reported 7 cases, including 1 of his own, in which the diagnosis had been established from examination of the fœces.

Glycosuria has been reported in a large number of cases, particularly in the postmortem group. Oser, in his series of 70 cases, found that it occurred 22 times, while Lazarus notes its occurrence in 36 of his 80 cases. Opie points out that this condition comes on late in the disease, after fibrosis of the pancreas has become so extensive as to involve the islets of Langerhans. Glycosuria does not necessarily mean, however, that surgical intervention will not still relieve and even cure the condition, as will be noted in the included statistics.

Loss of weight to a marked degree occurred frequently enough to attract attention.

In 14 of the cases (about 25 per cent), obstructive jaundice led to the incorrect diagnosis of gall stones in the common duct. Jaundice is due either to obstruction at the ampulla of Vater by an extruded pancreatic calculus, or to pressure upon the common duct by inflammatory swelling or stone in the head of the pancreas.

Associated pulmonary tuberculosis was found in 6 cases and in the case here reported. Its oc-



Fig 1. Roentgenogram showing calculi in the pancreatic duct. (From the X-ray Department of The Royal Victoria Hospital, Montreal.)

currence, however, can hardly be said to be more frequent than the association of pulmonary tuberculosis with diabetes mellitus generally. In only 1 case, that of Bissell, was a tuberculous lesion found in the pancreas.

The finding of gall stones in 4 cases and pancreatic carcinoma in 1 case may be considered in the light either of cause or effect, or as purely coincidental, the latter explanation applying with added force to the 3 cases showing duodenal ulcer.

In but 4 cases have pancreatic cysts been found, and the explanation given by some writers is that the duct of Santorini has been present and has remained patent.

The pancreatic stones are almost invariably located in the ducts. Seldom are they found embedded in the parenchyma of the gland. It has been noted that they do not tend to lodge in the terminal portion of the duct of Wirsung as it passes through the duodenal wall. The ducts behind the stones eventually become dilated, and in addition to the stones may also contain grumous material. The pathological changes in the parenchyma of the gland are characteristic. First, there develops an interlobular pancreatitis with small round cell infiltration and, later, fibrosis. The fibrosis gradually extends and eventually involves the whole parenchyma in a diffuse way, compressing the acinar tissue. Pressure from dilated ducts undoubtedly plays a part in this destructive process. As Opie has stressed, the islets of Langerhans are

TABLE II—POSTMORTEM CASES

Number of cases reported	25
Average age	(46.3 per cent) 50
Sex	
Males	11
Females	6
Not mentioned	5
Symptoms and Signs	
1. Pain	
Dull epigastric	4
Colic-like epigastric	12
Absent	3
Not mentioned	6
Referred to thoracic region of back	5
Reference not mentioned	10
2. Nausea and vomiting with attacks of pain	7
3. Glycosuria (always late)	10
4. Jaundice with attacks	6
5. Steatorrhœa	6
6. Diarrhœa with attacks	5
7. Stones in the stools	3
8. Melœna	1
9. Distention	2
10. Marked loss of weight	6
11. Irregular pigmentation of skin	2
12. X-ray findings (none mentioned)	0
Findings	
1. Calculi	
Multiple	24
Single	1
2. Pancreatic cysts	1
3. Abscess of the pancreas	2
4. Tuberculosis of the pancreas	1
Associated Findings	
1. Gall stones	2
2. Duodenal ulcers	2
3. Pulmonary tuberculosis	6

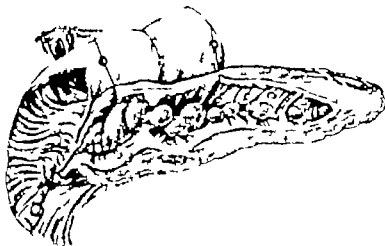


Fig. 8. Dis. leg. showing the pyloric end of the stomach, a portion of the duodenum, the pancreas, and adjoining tissues. Note the stones in the opened dilated pancreatic duct and tributaries. Probe in the common duct.

the last to become involved. The calculi have been described as varying from a pale yellow to a light grey in color. They are usually quite friable. They vary in size from sand-like particles to one described by Schuppmann measuring $1\frac{1}{2}$ inches in diameter. They are rough irregular some times jagged and the larger ones may even take on a stag-horn appearance from projections into dilated branch ducts. When multiple large stones are present they are often faceted as in the case about to be described. In cross section they show no definite concentric formation but are seen to contain organic material. Chemical analysis has been found to be substantially the same in all instances. Calcium carbonate and calcium phosphate form the chief constituents. Barron, who investigated this matter particularly, found that there also occurred less frequently small quantities of other phosphates and occasionally traces of cholesterol magnesium carbonate and calcium oxalate.

Regarding the causation of stone formation all the accumulated evidence points to a primary inflammatory condition, with stasis as a secondary factor. Not only do the accompanying pathological changes in the pancreas bear this out but the composition of the stones themselves offers additional evidence. Normal pancreatic secretion it has been shown, does not contain calcium salts. On the other hand it is well known that calcium salts are always found in excess in any inflammatory process. Just as calcium deposition in gall

stones is secondary to an inflammatory lesion, so it occurs also in pancreatic stones.

The following is an abstract of a case which came to autopsy at Ste. Anne's Military Hospital Ste. Anne de Bellevue Quebec. The history is based on records kindly supplied by St. Bartholomew's Hospital London, England The Boston City Hospital, Boston Massachusetts The Victoria General Hospital Halifax The Royal Victoria Hospital Montreal and the Ste. Anne's Military Hospital.

R. D. male aged 47 years, British born, civil engineer by profession, was admitted to Ste. Anne's Military Hospital on May 1900, in a dying condition.

From the age of 10 to the age of 18 years he had had discharging sinuses in his neck, probably tuberculous in origin. In 1904, he first complained of attacks of upper abdominal colic like pain accompanied by anorexia, vomiting, and loss of weight. These attacks are aggravated by taking food. He was admitted to St. Bartholomew Hospital, London the same year. At an exploratory operation, nodular mass found in the pyloric region was thought to be carcinoma of the pylorus and gastro-enterostomy was performed. The patient was considerably relieved for few months, but the attacks again occurred occasionally but not so severely. After coming to Canada, in 1905 he contracted typhoid fever and received treatment in The Victoria General Hospital Halifax, for 6 weeks. In 1906 he was admitted to The Boston City Hospital, because of the return of the attack of abdominal pain. He was treated with laxatives and enemata for 5 days and then discharged, relieved.

In 1907 1 year after the abdominal operation he enlisted in the Canadian Army and went overseas. While in England he was treated in military hospital for abdominal colic, and vomiting. He continued to have recurring attacks of a similar nature while overseas. In 1909, he returned to Canada.

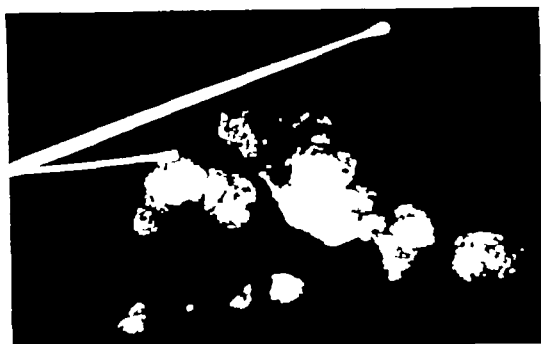


Fig 3 Roentgenogram of the fresh pathological specimen shown in Figure 1, with a probe in the common bile duct and another in the pancreatic duct as far as it could be inserted. Note the multiple stones in the pancreatic duct.

In 1920 he first noticed frequency of urination and a craving for sweets. The following year he developed a definite polyphagia. In 1923, he had a severe recurrence of epigastric colic and vomiting. He found that vomiting relieved his pain and he frequently sought relief by inducing it. The same year, he was admitted to the Victoria General Hospital in Halifax for these symptoms. There, for the first time, glycosuria was noted. In 1924, he again entered the same hospital on account of abdominal pain. Glycosuria was again found. It should be noted that he was disinclined to follow his dietary instructions, and, moreover, was addicted to the use of alcohol. In 1925, thirst and polyuria became more marked. In March, 1926, he attended the Boston City Hospital Clinic, complaining of pain in the left shoulder. A diagnosis of diabetes mellitus and alcoholic neuritis was made. In April, he was again admitted to the same hospital on account of his abdominal symptoms. Here it was recorded that he was addicted to the use of veronal as well as alcohol. Not long after this, in 1926, his abdominal symptoms entirely cleared up and never recurred. In August, 1927, he developed a cough and began to lose weight rapidly. He had hæmoptysis on two occasions during that month. Again entering the Boston City Hospital, pleurisy was found as well as his diabetic condition. Insulin was used for the first time, and on leaving the hospital he was taking a dosage of 20-0-20 units. He continued to lose weight steadily and his cough persisted. By February, 1929, he had lost 44 pounds.

On February 9, 1929, he was admitted to The Royal Victoria Hospital, Montreal, where the diagnosis of chronic pulmonary tuberculosis was added to that of diabetes mellitus.

Laboratory findings. Urinalysis showed urine, acid, specific gravity, 1.037, sugar + + +, albumen, +, acetone, trace, bile, 0, microscopic pus cells, scattered and in clumps. Blood count showed red blood cells, 4,140,000, white blood cells, 9,000, hæmoglobin, 90 per cent. Blood Wassermann was negative. Blood chemistry, urea, creatinine and cholesterol, normal values. Gastric analysis, normal findings. Stool examination, nothing unusual noted. Barium series showed a well functioning gastro-enterostomy. Shadows were noted at the level of the first and second lumbar vertebrae, suggesting calcified glands. These have since been identified as pancreatic calculi (Fig 1). X-ray examination of chest confirmed the diagnosis of pulmonary tuberculosis. The Tapp test showed a pathological gall bladder. Cystoscopic examination, with a pyelogram gave negative findings.

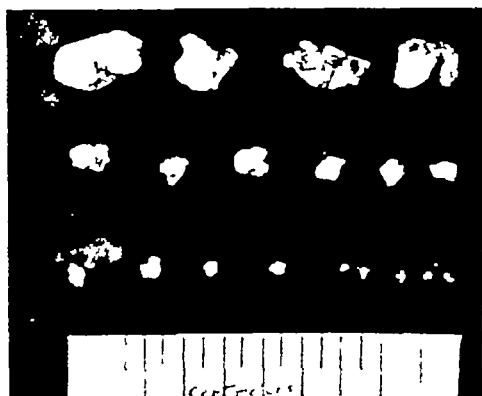


Fig 4. Stones removed from the pancreatic ducts showing various sizes and shapes, facetting is indistinctly seen.

The patient's pulmonary condition became rapidly worse and on May 1, 1929, he was transferred to Ste Anne's Military Hospital, where he died May 9.

Abstract of postmortem findings. The pancreas was buried in dense fibrous adhesions and was very much atrophied. Part of the adhesions were intimately associated with the gastrojejunal stoma. On palpation the pancreas was hard and fibrotic. Along the course of the duct of Wirsung several large stones could be felt which gave distinct crepitation. Gross sections of the gland showed this duct to be widely dilated throughout and filled with numerous greyish white stones of various sizes and shapes. While some were rough and irregular, the larger ones were faceted at contact points. Branches of the main duct were also dilated and contained many similar though smaller stones (Fig 2). In addition to the stones, the ducts also contained yellowish, grumous material and sand-like particles. The duct walls were all greatly thickened and the parenchyma almost entirely replaced by fibrous tissue. An X-ray picture of the extirpated pancreas was made (Fig 3), and this revealed the presence of many small stones in remote parts of the gland. These were afterward found to lie in dilated ducts. Some of the more accessible calculi were removed and photographed (Fig 4). Chemical analysis of these stones showed the chief constituent to be calcium carbonate, with a smaller amount of calcium phosphate.

In addition, there was extensive ulcerative tuberculosis of the upper lobe of the left lung and bilateral pleural effusion. There was also an empyema of the appendix, the kidneys showed cloudy swelling, and the spleen an acute hyperplastic condition.

Microscopic examination of the pancreas. Many sections taken from various parts of the gland all showed marked loss of glandular tissue with extensive replacement fibrosis. In some areas the latter contained considerable small round cell infiltration. What acinar tissue remained was present only in small islands, and these showed postmortem autolysis. Acinar tissue was relatively best preserved in the sections from the head but even here it was very far from normal. In none of the many sections could normal, or even nearly normal, islets of Langerhans be recognized, but here and there, embedded in the fibrous connective tissue indistinct remnants of these were seen (Figs 5 and 6). The duct walls generally were greatly thickened by fibrous connective tissue, while sections through the terminal portion of the duct of Wirsung and common bile duct just above the ampulla showed, in addition to this thickening, considerable surrounding fibrosis and small round cell infiltra-

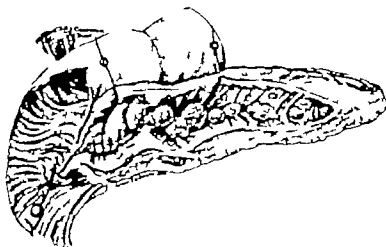


Fig. 2. Drawing showing the pyloric end of the stomach, portion of the duodenum, the pancreas, and adjoining tissues. Note the stones in the opened dilated pancreatic duct and tributaries. Probe in the common duct.

the last to become involved. The calculi have been described as varying from a pale yellow to a light grey in color. They are usually quite friable. They vary in size from sand-like particles to one described by Schuppmann measuring $1\frac{1}{4}$ inches in diameter. They are rough, irregular, sometimes jagged and the larger ones may even take on a stag-horn appearance, from projections into dilated branch ducts. When multiple large stones are present they are often faceted, as in the case about to be described. In cross section they show no definite concentric formation, but are seen to contain organic material. Chemical analysis has been found to be substantially the same in all instances. Calcium carbonate and calcium phosphate form the chief constituents. Barron, who investigated this matter particularly, found that there also occurred, less frequently, small quantities of other phosphates and occasionally traces of cholesterol magnesium carbonate and calcium oxalate.

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K. D. male, aged 37 years, British born, civil engineer by profession, was admitted to St. Anne's Military Hospital on May 29, 1918, in dying condition.

From the age of 10 to the age of 18 years he had had discharging sinuses in his neck, probably tuberculous in origin. In 1904, he first complained of attacks of upper abdominal colic-like pain accompanied by nausea, vomiting, and loss of weight. These attacks were aggravated by taking food. He was admitted to St. Bartholomew's Hospital, London, the same year. At an exploratory operation, nodular masses found in the pyloric region were thought to be carcinoma of the pylorus and gastro-enterostomy was performed. The patient was considerably relieved for few months, when the attacks again recurred occasionally but not so severely. After coming to Canada, in 1911, he contracted typhoid fever and received treatment in The Victoria General Hospital, Halifax, for 6 weeks. In 1912, he was admitted to The Boston City Hospital, because of the return of the attacks of abdominal pain. He was treated with laxatives and enemas for 5 days and then discharged, relieved.

1913, 2 years after the abdominal operation, he enlisted in the Canadian Army and went overseas. While in England he was treated in a military hospital for abdominal colic and vomiting. He continued to have recurring attacks of nodular nature while overseas. In 1918, he returned to Canada.

OPERATIVE TREATMENT

The excellent results that have attended operation in recent years deserve special emphasis. Not only have the end-results been gratifying, but the mortality rate is satisfactorily low, being approximately 6.5 per cent. It is notable that in neither of the two deaths following operation did either fat-necrosis or peritonitis occur, in none of the cases did a permanent fistula develop. The secret of this, as Seeger has pointed out, is adequate drainage, preventing retroperitoneal accumulation of pancreatic secretion. All of the 7 cases reported with glycosuria previous to operation recovered. In 4 of these a definite postoperative improvement in sugar tolerance is recorded.

Various avenues of approach to the pancreas have been described. In general, however, the route chosen has depended on the location of the stones. When these are located in the head of the gland some surgeons, notably Sistrunk, have favored retracting the second part of the duodenum medially and thus reaching the pancreas from behind. Dalziel, in 1902, reported a case in which he successfully removed four stones from as many different parts of the gland. Moynihan and others have opened the duodenum and removed stones through the ampulla. Hartig's case had an associated carcinoma of the head of the pancreas from which the patient died 5 months later. To discuss the relative merits of the different operative procedures does not come within the scope of this paper. One is content to stress the gratifying results that have attended the surgical treatment of this condition since Caparelli, in 1876, reported the first case successfully operated on.

SUMMARY

1 Pancreatic lithiasis is a comparatively rare condition, there having been only slightly over 100 cases reported.

2 Whereas most of the earlier cases reported were from autopsy findings, the majority in the last 50 years have been successfully operated on.

3 Epigastric pain of both dull and colic-like nature is the commonest symptom, but unfortunately there is no consistency in radiation.

4 Steatorrhea and diarrhea attract particular attention in the symptomology. These symptoms, together with the occasional finding of calculi in the feces, make the examination of the stools of great importance.

5 Glycosuria of true diabetic character is a frequent finding late in the condition. It appears to be coincident with extensive destruction of the islets of Langerhans by the fibrotic pancreatitis which occurs with this condition.

6 Jaundice occurs often enough to lead frequently to the incorrect diagnosis of cholelithiasis.

7 Correct clinical diagnosis is difficult, and though the roentgen-ray is of great value it may, as in our case, not be conclusive, while even at operation stones may be missed, particularly if single. A peculiar crepitus when multiple stones are present has been described.

8 Surgical treatment has yielded very gratifying results from every standpoint. The mortality rate is less than 6.5 per cent. When properly treated the presence of diabetes mellitus does not constitute a contra-indication to operation.

9 Characteristic pathological changes occur in the parenchyma of the gland, beginning as a chronic interlobular pancreatitis and gradually involving the whole gland in a fibrotic process, with resultant atrophy and loss of parenchyma. The islets of Langerhans are last to be involved.

10 The calculi are composed for the most part of calcium carbonate and calcium phosphate. These findings are suggestive of an inflammatory etiology.

11 Associated pulmonary tuberculosis has been noted in a number of cases. The incidence of this is, however, probably not more than might be expected in diabetes mellitus generally.

12 A typical case is reported with a history of 25 years, and with the autopsy findings. Glycosuria was present during the last 5 years of the condition and active pulmonary tuberculosis only during the last 6 months.

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Fig. 5. Low power photomicrograph of pancreatic tissue. The darker areas are islands of pancreatic tissue; the lighter dense fibrous tissue. A dilated pancreatic duct is seen at A.



Fig. 6. High power photomicrograph showing the extensive fibrosis in the pancreatic tissue, with small island of degenerated residual acinar tissue.

tion (Fig. 7). There was considerable peripancreatic inflammatory connective tissue which involved also the adjacent lymph nodes.

This case illustrates well the difficulty of making an accurate diagnosis of pancreatic lithiasis, even with roentgen-ray assistance. This difficulty is attested to by all writers, but on the other hand,



Fig. 7. Photomicrograph (plasma) of transverse section through the ampulla of Vater showing the common bile duct A and the patent pancreatic duct B.

the more recent statistics certainly show a decided improvement. Not only have a larger number of definite pre-operative diagnoses been made than formerly but in a still greater number of cases have calculi been suspected and their presence confirmed at operation. Because of earlier recognition and treatment relatively fewer cases with glycosuria have been recorded in recent years. In some cases, even on direct palpation of the pancreas a simple stone may be difficult to locate especially if extensive fibrosis be present. On the other hand, attention has been called especially by Link and Sistrunk, to a peculiar crepitus that exists when there are multiple stones. The value of the roentgen-rays in the diagnosis has been particularly stressed by Mayo-Robson especially in view of the composition of the stones. Hartig, however, describes a case in which X-ray examination was negative, but several large stones were found at operation. On the other hand, Lindsay's 2 cases both showed suggestive shadows, and in his more recent case this writer felt that this examination definitely confirmed the diagnosis. La Courte and Charbonnel X-rayed their patient after operation only when several overlooked stones were seen. In a few instances, including our case, however the shadows have been mistaken as can readily be understood for calcified glands which are commonly found in this region. In at least two cases the X-ray diagnosis of renal calculi has been made.

were firm whereas those formed during parturition always had a perceptible response when pulled and had retained elasticity. Browne observed that knots formed early in fetal life are flattened out and bandlike. When these knots are untied there is left a grooving in the cord which curls involuntarily and the jelly of Wharton has disappeared at the site. The vessels are compressed, of diminished caliber, and the vessel walls hypertrophied. The section of the cord proximal to the knotted area is often oedematous, the other end thin, tenuous, and pale. Recent knots of parturition, as when the cord becomes coiled around the *os uteri* and the infant is drawn through the loop or when the fetus passes through a loop spread out in the lower uterine segment, show no anatomical changes, except possibly a little oedema on the fetal side of the cord.

ILLUSTRATIVE CASES

CASE 1 V. C., female, white, 34 years of age, who had previously given birth to two children, was delivered at full term of a normal male child weighing 10 pounds, 3 ounces. The pregnancy was uneventful. Fetal life was normal. Ten days prior to admission to the hospital some pain had been felt with unusual fetal activity which decreased without much perceptible motion since this time. At birth the cord was found to be tied in a knot of the type illustrated in Figure 2, commonly called a lover's or sailor's knot.

The mechanism of the formation of such a knot admits of two possibilities.

Method A, Figure 4 1, The fetus is pictured in the uterus in upright position. The cord has formed a noose at one side of the fetus and part of the cord is draped over the left shoulder with the placental end crossed over the fetal end. 2, The fetus dives forward so that the fetal end of the cord passes over his head and the placental end beneath his chin. 3, The somersault of the fetus is half complete. The head is beginning to pass through the loop. 4, The fetus is twisted slightly. The head and shoulders have passed through the loop. 5, The fetus is through the loop and again in upright position. The knot formed is a lover's or sailor's knot.

Method B, Figure 5 1, The fetus is in upright position with two strands of the cord passing in front of the fetus and a loose coil at the left side. 2, The fetus has made a half-twisting of the body toward the loop with the placental end of the cord lying over the fetal end. 3, The fetus has turned completely around forming a second coil about the body. 4, The fetus somersaults forward passing head first through coil and loop. 5, The somersault is half complete. 6, The knot is completed, being the same type of knot as that formed by method A.

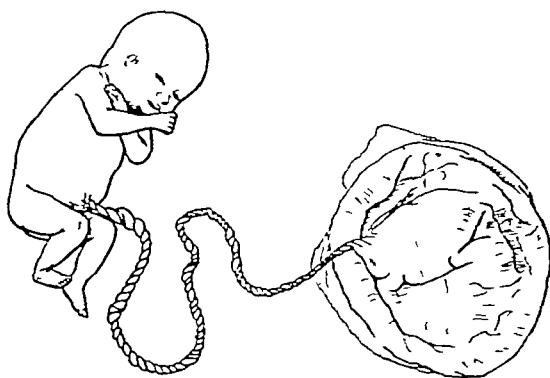


Fig. 1. Umbilical cord of fetus of 4 months' pregnancy presenting 9 or twists.

CASE 2 R. B., female, white, 42 years old, gave birth to male twins by spontaneous delivery May 30, 1930. One twin weighed 6 pounds, the other 6 pounds, 5 ounces. They were similar twins in the same amnion without dividing septum, born by breech presentation. The membranes ruptured before admission to the hospital. X-ray of the abdomen on May 28 showed the presence of twins in the uterus. At this time the fetal heart beat was perceptible. Pregnancy was uneventful. At delivery it was discovered that the umbilical cords were intricately knotted.

Twins in one amnion often have intertwined cords but rarely intricate knotting. Figure 3 shows the knotting and intertwining of the cords of these uniovic twins.

The effect of the knotting of the umbilical cord on the life of the fetus has been the subject of much controversy. Guinness reports a case in which a knot in the cord caused acute hæmorrhage. The mother during the second pregnancy and just before parturition was seized with continuous but not severe hæmorrhage. No signs of placenta prævia were present. No fetal heart sounds were audible. After the vagina was tightly packed the child was stillborn in vertex presentation followed by blood clots and placenta. The cord, longer than the average, contained a single complete knot which blocked fetal circulation and caused the separation of the placenta and hæmorrhage before labor set in. Some days previous to entrance the patient had complained of great fetal activity which suddenly ceased.

Kittler reports a case in which a woman strained herself during the third month of pregnancy by reaching for a door knob to save herself from falling. She was delivered prematurely during the seventh month. About the body of the dead fetus was a lasso knot so tightly drawn that the abdomen bulged markedly above and below the cord.

KNOTTING OF THE UMBILICAL CORD

WITH A REPORT OF TWO CASES AND ILLUSTRATIONS OF THE MECHANISM OF KNOT FORMATION

W. G. ATWOOD M.D. F.A.C.S. FALL RIVER, MASSACHUSETTS

IN human beings the umbilical cord is subject to many kinds of torsion, coiling, looping and knotting during pregnancy or during parturition. Torsion of the cord is a common occurrence. In a case recently admitted to the hospital the umbilical cord of the aborted fetus of 4 months pregnancy was twisted ninety-one times (Fig. 1). DeLee records a case in which the death of the fetus might have resulted from stricture of the cord which was twisted 380 times. There is the remote possibility that the activity of fetal death agony may produce the torsion or that the cord may become twisted after the child's death by uterine contractions. In the latter case no adhesions would be found between the coils of the cord and when untwisted the shape of the cord would not be permanently altered.

Coiling about the neck or body of the fetus has been found in 25 per cent of the cases, but knotting of the cord in only 0.5 per cent. Von Winckel considers the occurrence of knotting of the cord rare, being found in not more than 0.4 to 0.5 per cent of all births. Chantreuil found seven knots of the cord, six simple and one double, in 1,000 deliveries. Von Hecker records 31,590 births in which he found true knots of the cord 116 times a ratio of 1 to 274 births.

Such anomalies are not characteristic of the lower animals, however. Torsion has been discovered in about 40 per cent of cases, chiefly in horses and pigs. Seldom has the cord been coiled or looped about the neck of the offspring and never has a knotted cord been observed. Sellheim ascribes the greater occurrence of twisting and knotting of the cord in human beings to their upright posture, their ability to swing about rapidly on a vertical axis, the heavy head of the human fetus as compared with the body, and to the fact that it must remain longer in bent position before reaching the pelvic outlet. The theoretical transmission of the effect of physical motion of the mother on the contents of the uterus has led one writer to regard these multiple high grade torsions and knots as the automatic registering apparatus of outside stimuli on intra-uterine life. Schneider offers the hypothesis that the knots are formed in the developmental stage at the time when the body stalk is fusing with the omphalo-

mesenteric duct as it passes into the amniotic cavity when the embryo is about 5 millimeters in length. Most authorities believe however that the most favorable time for knot formation during pregnancy is from the ninth to the twelfth week of intra uterine life. At this time the fetus is very small and is swimming about in an abundance of amniotic fluid. Contributing factors are an extremely long cord, hydramnios, exaggerated fetal movements, or violent movements on the part of the mother. It is evident that a long cord and a great amount of amniotic fluid will facilitate fetal movement. But authors have reported finding knots in very short cords. Collyer found two knots in an umbilical cord which measured only 6 inches. Such cases are exceptional.

The formation of a single true knot is a formidable process which is influenced by contractions of the uterus, passivity and subsequent sudden activity on the part of both mother and fetus, and the laws of gravitation. The fetus itself may slip through the loop or the loop may accidentally fall over the head of the fetus. The first stage in the process is torsion which is due to a simple twisting of the fetus on the axis of the umbilical cord. The mechanics is similar to that involved when the pedicle of an ovarian cyst becomes twisted. If the torsion is prolonged, a coil or loop may be formed. If a particular movement or series of movements then drives the loop toward the fetus or the fetus toward the loop and the fetus reverses its motion, diving through the coil, a variety of knots may result. Experiments with weights and strings have revealed a chaotic number of possibilities of knot formation.

The situation of the knot often may be used as an indicator to mark the time of its formation. If the knot is formed early it will be close to the navel. If late it will be at the placental end. McCaffrey however discovered through experimentation that a pressure equal to that exerted by the pumping of the fetal heart has made the knot travel 6 inches along the cord so that this method is not impeccable.

Discrimination between knots formed during pregnancy and those resulting from labor can ordinarily be made with little effort. Sellheim noticed that knots found in premature fetuses

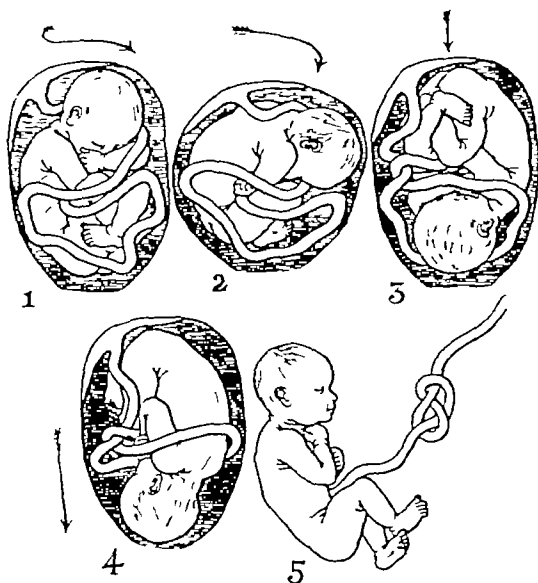


Fig 4. Method A

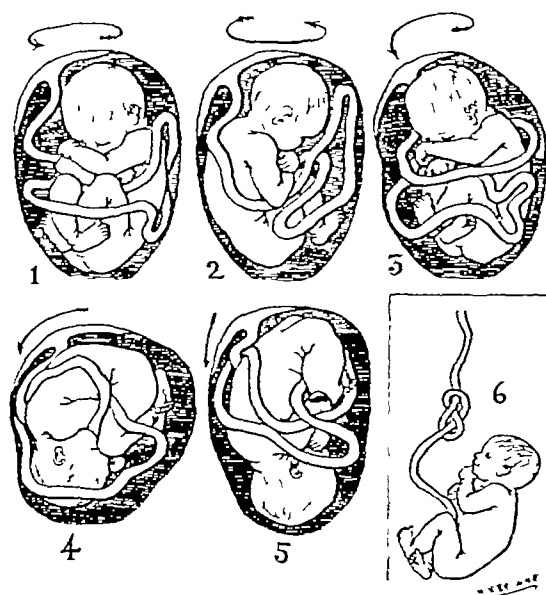


Fig 5 Method B

The separate cords of twins provide excellent opportunities for unusual twisting, interlacing, and knotting, especially when the two fetuses are encased in one amnion without a dividing septum. Rossier reports a case with excellent illustrations of univitelline twins whose cords were interlaced and intricately knotted. Sonntag collected 23 cases of entwined and knotted cords in single amnion pregnancy. In 2 cases only, both of the twins lived. In 1 of these 2 cases the cords were both twisted and knotted, in the other, merely knotted. In 5 cases 1 of the twins lived and was born at term, in 4 of the cases both interlacing and knotting were present. The rest of the cases, 16 in number, were miscarriages at from 4 to 5 months, in which all but two of the cords showed interlacing and knotting, in these two, knots only were formed. Freund reports a case of mono-amniotic twins who died after 6 months' pregnancy. One cord longer than the other had encircled the shorter one three times and then looped itself over it to form a single knot. The first circling of the cord was so tight that the cord was compressed markedly. According to Rosenburger, one mono-amniotic twin pregnancy occurs in 60,000. Sachs reports a case of five knots in the cords of twins in one amnion and calls the condition extremely rare. Gornick reports finding many conglomerate knots in the cords of mono-amniotic twins of 8 months' pregnancy. The female child was delivered first, badly asphyxiated. The second child, male, could not be revived, its respiration being cut off by the

torsions and knottings. The author stated that in only 4 of 16 cases in his experience were the twins born alive. In 7 cases one child lived, and in 5 both died. Kauffmann reports the spontaneous birth of living male twins in a single amnion with no separating membrane, whose cords were tied in a double sailor's knot.

In his report of 3 cases of death of the fetus owing to abnormalities of the umbilical cord, King makes the suggestion that more such cases be reported. In this way it will become possible to arrive at a more accurate estimate of infant mortality from this irremediable anomaly.

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17. VON WINCKEL. Quoted by F. J. Browne, loc. cit., p. 17.

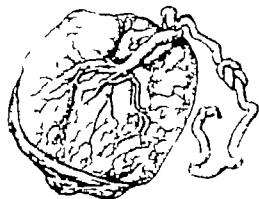


Fig. 2. Umbilical cord tied in a sailor's or lover's knot.

An interesting case of knotting of the cord without injury to the child is one reported by Fleming. A woman, 28 years of age, was delivered at full term of a large, healthy boy. The cord contained two knots, one a figure-of-eight located about one foot from the placental end, the other a single knot at about the same distance from the umbilical end. The cord was 4 feet long and both knots were loosely tied. Fleming had discovered single knots in the cord in previous cases but never two knots in the same cord. In von Hecker's 31 590 cases there were 115 instances of cord knotting and in no case had the knot affected the child's development in any way. McCormick delivered with low forceps a primiparous patient. The baby was fully developed and unanesthetized. The cord presented a knot in the form of a rather loose figure-of-eight. In the prenatal history there was only one possible cause of the knotting of the cord at 7 months gestation the patient had fallen, the effects of which necessitated hospitalization for five days.

From the few cases in the literature it may be inferred that knotting of the cord has caused the death of the fetus in about 50 per cent of occurrences. Knots formed during delivery are almost never serious. If knots are formed in early gestation, they are more apt to prove fatal by traction on the cord producing asphyxia. Sometimes they may be tight enough to interfere with the development of the fetus when the constant pulsation of the cord and the resulting turgescence may prevent a tightening of the cord to the point of asphyxiation. Certainly if the knots are slack they have no effect on fetal development, and von Wöckel believes that they can never be drawn tightly enough to interfere with the circulation until labor begins. Baudeloque found in one

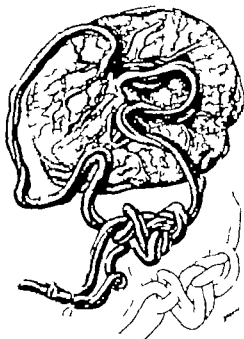


Fig. 3. Knotting and interlacing of cords of similar velvety twins.

cord two double knots so tightly drawn that when the cord was finally untied a deep groove remained at the site of the knot, yet the child was normal. Chantreuil affirms that tight knots can cause death or emaciation of the fetus from undernourishment.

To throw some light on the problem, Tanner performed an interesting experiment. He made a knot in an umbilical cord and pulled it as tightly as possible. Then he pumped fluid into the cord. He found that fluid would always pass through the knot which partially untied itself when the vessel in front of the knot became swollen enough to exert pressure on the cord. He came to the conclusion that the fetal heart could in every instance exert a degree of pressure sufficient to maintain the fetal circulation.

Browne went a step farther with the same sort of experimentation. By applying different weights and pressures to the knotted cord he showed that under certain conditions more pressure was required to force the fluid through the knot and that this pressure was greater than the fetal heart could exert. He concluded, therefore, that in some cases a knot did interfere with and even completely obstruct cord circulation.

by which hæmostasis could be obtained without the placing of ligatures, and at the same time without injury of the tissues is obvious. For this purpose the application of the high frequency electrical current has shown great possibilities, but as already stated, it must be done so lightly and delicately as to do nothing more than to cause sufficient adhesion of or alteration in the tissues to prevent opening up of the bleeding points, and at the same time to avoid necrosis sufficient to impair or retard wound healing.

In the development of the wonderful apparatus which has gone on apace, various types of current and variations of intensity are now afforded, so that if the operator will take the trouble to master the subject, he has at hand a great opportunity for the useful employment of electricity in his surgical work.

With the constantly changing personnel in the surgical resident staff, however, visiting surgeons find considerable difficulty in keeping the incoming men informed as to the complexities of the apparatus in use. It has, therefore, seemed to me to be of prime importance that the whole electrical armamentarium be simplified and standardized as much as possible. With the active co-operation and expert advice of the manufacturers, efforts have been made to simplify and make cheaper the apparatus necessary for satisfactory electrosurgery. The object has been to construct and standardize the apparatus so that perfect duplication of performance can always be depended on, and that no extraordinary electrical or mechanical aptitude is required of the surgeon also to reduce the cost so that this great advance in surgery could be more universally adopted. I will not attempt to describe in detail the small compact machine to which the final model has been brought, as shown in Figure 1. The entire mechanism is encased in a wooden cabinet a little over one foot cube. There is only one adjustment, namely the lever which regulates the amount of power. The position of this lever shows one, at a glance, approximately how much output power it is set for. The spark gaps are fixed, and require no adjustment or attention. They will need compensation for wear about once every five hundred operations, and should have a useful life at least four times that great.¹ The entire gap assembly can be replaced in one unit at a minimal expense. A special arrangement maintains constantly accurate spacing of the spark gaps, irrespective of expansion and contraction of the metal due to temperature changes while in

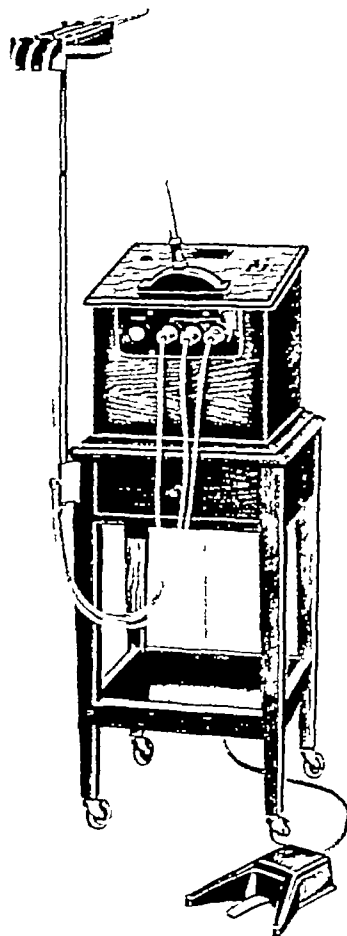


Fig. 1. High frequency electric apparatus or "coagulator" designed by Liebel Flarsheim in conjunction with the author.

operation. This is very vital in obtaining uniform reproducible results.

A very important feature is that all of the voltage of the electric circuit is developed in one direction. In other words, the terminal marked "patient" is substantially at earth potential, so that the surgeon can touch any portion of the patient without danger of the high frequency current backing up and puncturing his glove or burning his fingers. The electrical circuits are completely ground free, and therefore shockproof. The patient need not be especially insulated from any metal objects, although where the patient does come in contact with the metal, this contact should be a good one to prevent sparking or

¹ Much of these details have been furnished by the Liebel Flarsheim Company, Cincinnati, Ohio.

ELECTROHEMOSTASIS IN PLACE OF LIGATURES

PRESENTATION OF A SMALL, SIMPLE APPARATUS FOR ELECTROCOAGULATION

HUGH H. YOUNG M.D. F.A.C.S. F.R.C.S.I. BALTIMORE

THE use of the high frequency electrical current, which was introduced into medicine some 25 years ago, received its greatest impetus from urologists, who have demonstrated its great usefulness, particularly in the treatment of vesical tumors. This work, which has revolutionized intravesical neoplastic surgery led to a further development known as diathermy which has been applied to practically all branches of medicine and surgery. Then came another development of electrosurgery, the electric scalpel, and numerous articles have appeared from enthusiasts, who have predicted a rapid replacement of the cutting scalpel. As a result of intensive experimental work by Bovie and others, the range of current and extension and usefulness of high frequency electrosurgery have been greatly increased, and in the past a years the literature on this subject alone has filled many pages of the medical journals here and abroad. Leaders in the profession have come forward to approve of its use in almost every type of surgery. A mention of the various articles is impossible but we may refer in passing to papers by Harvey Cushing and Charles A. Elsberg on electrosurgery in the removal of intracranial tumors, Matson on the cauterization of adhesions in artificial pneumothorax, F. M. Mikella on the treatment of lesions of the cervix, L. Davis and B. N. Groen on its use in neurological conditions, H. E. Mock in thyroidectomy, G. A. Wyeth in various neoplastic lesions, Howard A. Kelly, John Anderson, and G. E. Ward, and others in general surgery particularly the surgery of very hemorrhagic organs, such as the liver, spleen and kidney, and finally A. J. McLean who has discussed the underlying principles and results obtained by the Bovie electrosurgical current generator. Most important is the recent book by Kelly and Ward. Of great interest has been the development of various modifications of my prostate punch with different types of electrocoagulation and cautery. In these various papers it has been demonstrated that comparatively bloodless surgery could be carried out rapidly and effectively by electrosurgery.

I have been greatly impressed with the value of electrosurgery in arresting hemorrhage particularly in the cortical bleeding which occurs

in the kidney and in the replacement of ligatures where possible. I have not been convinced that in the ligation of blood vessels of any size electrosurgery should be used instead of the safe and certain methods of ligation. But in extensive operations which would ordinarily require great numbers of ligatures from small bleeding points, the value of electrosurgery is great, if the technique adopted is such as to leave a minimum amount of destructive tissue change. Ligatures themselves are recognized as distinct impediments to perfect wound healing. Years ago Dr. Halsted was most insistent on the great advisability of picking up with artery clamps very small bits of tissue for ligation and the avoidance of mass ligation, which leads to the necrosis of large areas of tissue and consequently endangers proper wound healing. To minimize the amount of tissue clamped and ligated he brought out the pointed Halsted clamp and subsequently the mosquito clamp with which very small amounts of tissue are picked up and ligated. By means of his very careful haemostatic methods and the avoidance of mass ligation, Halsted had been able to obtain perfectly dry wounds, discarding drainage tubes and thereby obtained perfection in closure and healing which had rarely been accomplished before. The great advantage of complete haemostasis, as insisted upon by Dr. Halsted has been abundantly proved. The one disadvantage has been the considerable lengthening of the operative procedure as a result of such meticulous care. When it is possible for the surgeon to proceed with his operation, the bleeders on each side of the wound being rapidly caught and clamped by expert assistants, little or no delay is encountered until the time for ligation of the bleeding points occurs. Here one is often uncertain just what points need ligation, and which clamps may be safely removed without a ligature. As a matter of fact, the mere compression caused by a clamp, which has remained *in situ* for some time, is often sufficient for haemostasis. The importance of avoiding large numbers of ligatures is self-evident. With a wholesale removal of clamps numerous bleeders are encountered, the wound becomes stained and subsequent placing of clamps and ligatures is time consuming. The advantage of some method

operations upon the cortex of the kidney, we have long used some form of electrosurgery to avoid great hæmorrhage. The ordinary electrocautery has for this purpose been valuable, but the use of electrocoagulation by the high frequency current is still more valuable, and G. Ward deserves much credit for his demonstration of the great value of both the electric scalpel and the high frequency snare in removing portions of the kidney (and also spleen and liver) and in the avoidance of hæmorrhage. The only objection to the more considerable electrical current which is necessary to carry out such procedures is that tissue coagulation extends more deeply than in the trivial destruction necessary for cessation of hæmorrhage by the light application of the current to clamped

areas, but as Ward has shown, even though such areas are not approximated by sutures, healing of the kidney wound is satisfactory. Further experience may be necessary to determine whether it is safe to do away completely with ligatures of the important vessels in the renal tissues, which have been arrested by the electrical snare or knife. I have found this apparatus particularly adapted to the fulguration or electrocoagulation of vesical tumors by means of the cystoscope or suprapubically. The manufacturers have, I believe, obtained in a marked degree the desiderata of simplicity, completeness, transportability, and marked reduction in price, everything which they were asked to accomplish.

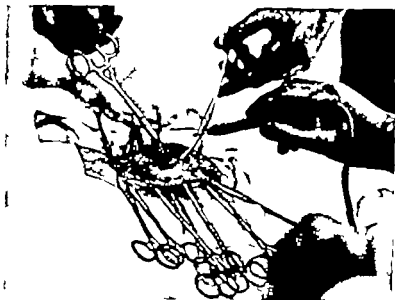


Fig. Showing method of applying electrode momentarily to arrest bleeding point.

burns from a slight amount of static always present when high frequency apparatus is in use. A new device, by which the lever controlling the amount of current is locked in place so that it cannot be moved by the accidental touch of an assistant during the operation is an important feature. Into this lever a glass rod can be inserted and locked. It is sterilized with the instruments, and put in place at the beginning of the operation. The cords, electrodes and their holder are also sterilizable and when not in use are held in the sterilizable rack, as shown in Figure 1. In order that the operator may have at hand several different types of electrodes ready for instant use, three such cords with operating handles are provided in addition to the cord which is attached to the metal plate upon which the patient lies.

When the surgeon has determined exactly the amount of current required for the type of work he is going to do, it is only necessary to set the lever at this point on the numbered scale in order to have exactly the same current at each operation. The length of time for each application of the electrode of course will vary according to the situation, and that alone will come with surgical experience. The object of the surgeon should be to use no more current than necessary and for as short a period as will accomplish what he wishes. I found the apparatus most valuable in replacing ligatures for the arrest of hemorrhage

from bleeding points that have been clamped during operation. When it is desired to remove these clamps, the operator and staff can carry out an extremely rapid technique in which the assistants have the clamps elevated in position, and the operator touches only momentarily each clamp (Fig. 2) which is then removed by the assistants. In this way some fifty clamps can often be removed in a minute. The electrical current hardly does more than to cause a sealing of the bleeding points and very little destruction of tissue or actual necrosis. In cases in which the mass of tissue is larger and in which the mass contains vessels of distinct size, a little longer contact of the electrode upon the shaft of the clamp is necessary but here again the operator should aim to avoid any more tissue injury than is absolutely necessary. If arteries or veins of importance are encountered, they should usually be marked for ligaturing with catgut or silk but even in these cases with care it is often possible with the electrode to obtain hemostasis and satisfactory sealing of the vessel. The use of the electrical current in such cases will have to be guided by the experience and prudence of the surgeon. In important operations it is wise not to take any chances lest this important advance in surgery be discredited.

Electrosurgery has apparently revolutionized hemostasis in brain surgery and is one of the greatest advances in modern neurosurgery. In

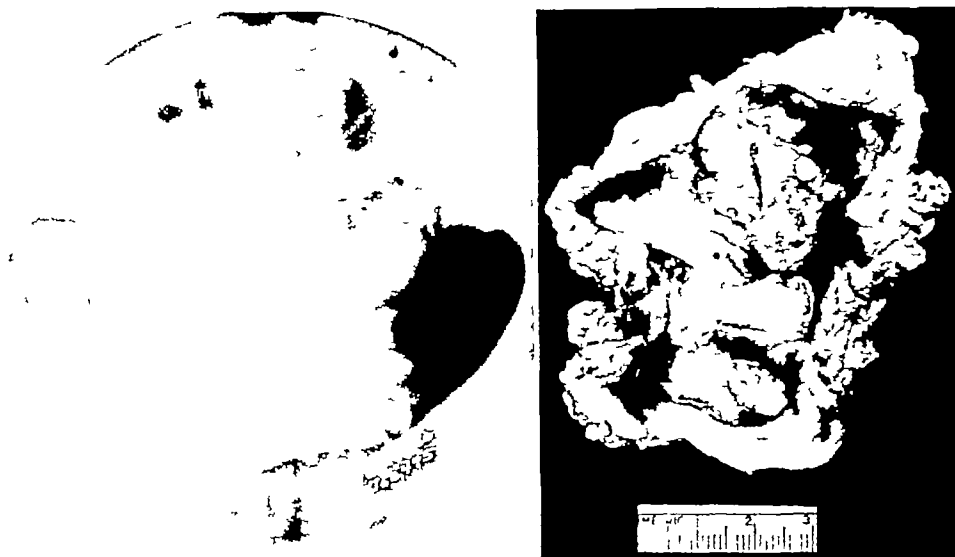


Fig 2 At left, diverticulum in region of left side of dome of bladder Both bladder and diverticulum filled with opaque solution, at right, div. ericulum resected, disclosing stones

Even though it seemed that the diverticula were associated with prolonged obstruction at the neck of the bladder, the phenolsulphonephthalein test indicated good renal function, as a rule, in most cases 40 to 50 per cent of the dye was excreted in 2 hours. In cases in which renal function was not good, suprapubic drainage seemed to restore satisfactory ability to excrete the dye. This indicated that renal injury probably was not permanent. Other tests of renal function, such as determination of blood urea, were parallel.

The quantity of residual urine in the bladder was large, 12 ounces (350 cubic centimeters) was the average. In only one case was residual urine absent. In 10 cases the bladder was so distended as to extend above the symphysis pubis.

Cystoscopy and cystography. The cystoscope or the cystogram was used in all of these cases, and thus, accurate knowledge of the condition within the bladder was known before operation. Since the cystogram has become common in the visualization of the bladder, the accidental finding of diverticula at operation is almost unknown. By combining the use of the cystoscope and the cystogram, the surgeon can outline his course of attack before the bladder has been opened.

Associated lesions. Because we believe that diverticula are caused by congenital weakness of the bladder that is manifested because of the obstruction, a study was made to see how much evidence of other abnormalities could be found.

The result was unexpected. Almost half of the patients had hernias of some sort, that had been present all their lives or had developed following some other operation or injury. The hernias were, in the order of frequency, inguinal, ventral, umbilical, femoral, and diaphragmatic. Obesity was marked in about a third of the cases. Diabetes was found in 3 cases and unilateral complete du-



Fig 3 Large diverticulum arising from right wall

THE RELATION OF DIVERTICULA OF THE BLADDER TO OBSTRUCTION OF THE VESICAL NECK

WALTMAN WALTERS, M.D., ROCHESTER, MINNESOTA

Division of Surgery The Mayo Clinic

AND

STANFORD W. MULDBOLLAND, M.D., ROCHESTER, MINNESOTA

Fellow in Surgery The Mayo Foundation

IMPROVEMENT in methods of urologic diagnosis has made the finding of diverticula of the bladder far more simple than formerly when they were found only at necropsy or accidentally at the time of operation on the bladder. It was not until 1906 that Young added 3 cases to the 5 that had been reported in which diverticula had been successfully excised. Now with recognition of obstruction of the vesical neck infection within the bladder and due regard to renal function, surgical treatment has become fairly common.

Diverticula of the bladder occur with all types of obstruction of the vesical neck, but not all cases of obstruction are associated with diverticula. Why this is so and why good results are obtained in certain cases and in others the patients must almost continually be under the watchful eye of their physician remains to be determined.

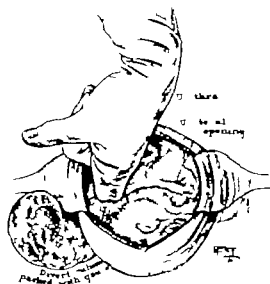


Fig. 1 Extravesical section of diverticulum of the bladder.

REVIEW OF MATERIAL

In the 30 cases chosen for this review, operation had been performed by one of us (Walters) in the course of the last 3 years. All of the cases have been studied in detail. A few were chosen for presentation because of some marked feature of interest in the observations, operation, or end-results.

Age. Sixty years was the average age of the patients. Five patients were aged less than 44 years, 4 of whom were in the fourth decade of life. In these 5 cases there were several features in common. The ages were 34, 37, 38, 38, and 43 years, respectively. The youngest had the shortest history that of trauma to the perineum 4 months previously with later retention of urine. The next older had sudden complete retention from urethral stricture and could not be catheterized. One of the patients aged 38 years had had flakes and pus in the urine for years. The other patient who was aged 38 years, and the patient who was aged 43 years had had difficulty in emptying the bladder for 18 and 20 years, respectively the latter noted burning on urination at the age of 6 years. Therefore young adults with diverticula had had obstruction at the vesical neck of long standing, or obstruction of the urethra had occurred from trauma.

Symptoms. The complaint of all the patients was urinary obstruction. The average duration of the complaints was 8.7 years, indicating that the process, as a rule, was rather prolonged. More than half of the patients complained of nocturia and frequency as the most prominent symptoms. In an equal number there was difficulty in urination, such as slowness in starting the stream and a feeling that the bladder was not empty. Painful urination and burning were usually late symptoms and were accompanied by pain in the bladder and in the perineum. Hematuria was uncommon, whereas cloudy urine was noted by the patient in about a third of the cases.

Observations at examination. A high degree of infection of the urine was noted in all but 4 of the cases.

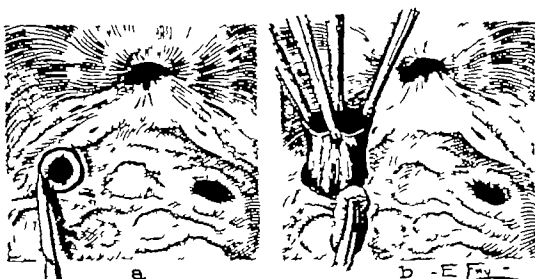


Fig 5 At left, circular incision around neck of diverticulum, at right, transvesical dissection of sac of diverticulum.

tissues are then thoroughly protected with gauze packs. The pus and urine are swabbed out of the pouch. The diverticulum is thoroughly cleansed from within with 2.5 per cent aqueous solution of mercurochrome.

Many ingenious methods have been devised for holding the diverticulum open during dissection. Lerche suggested the method of inflating a small rubber bag, after inserting it into the diverticulum. Lower suggested packing the diverticulum full of gauze, so that it may be well outlined, or traction may be exerted by fingers inserted into the sac, and the dissection can be made by bimanual manipulation. Large diverticula are almost always adherent to the ureter. A ureteral catheter inserted into the ureter will assist in identification and aid in avoiding injury.

The diverticulum is dissected free from surrounding tissues and is excised at the neck. The vesical mucous membrane is then closed by sutures over which the vesical muscle is approximated by two rows of interrupted sutures of chromic catgut. The ureteral catheter can then be removed. It is usually advisable to place a drain in the perivesical space at the point where the sac was dissected free. The bladder is then temporarily drained by means of a catheter carried out the suprapubic incision.

CASE 1. A man, aged 56 years, had a huge, multiloculated diverticulum which contained many stones. He gave a long history of obstruction of the vesical neck due to a median bar. A stone had been removed from the bladder in 1920 after 4 years of difficulty. For 6 years he had had frequency, and burning on urination. In the 6 to 9 months before his registration, he had experienced difficulty in starting the stream and had lost 25 pounds. The bladder was distended upward as high as the umbilicus. The concentration of urea in the blood was 62 milligrams in each 100 cubic centimeters; roentgenograms of the region of the bladder gave evidence of multiple vesical calculi, a cystogram (Fig. 2) disclosed a large diverticulum 6 by 4 centimeters in various diameters arising from the dome.

At operation, October 10, 1930, a huge diverticulum (Fig. 2) 7.5 and 5 centimeters in various diameters was



Fig 6 Diverticula arising from right and left sides of bladder. The bladder is empty.

found lying on top of, and mesial to, the left ureter. The diverticulum, which contained two stones, was removed by the extravascular method. The patient gained 15 pounds in weight in 18 days but there was difficulty in getting the wound to heal. A transurethral punch operation was performed November 5, a fibrous median bar being removed. There did not seem to be any fibro-adenomatous hypertrophy of the prostate gland.

CASE 2. A man, aged 38 years, had been troubled by straining on urination for 15 or 20 years. He had a feeling that the bladder did not empty. Dilatation of a urethral stricture had given some relief. There was cystographic evidence of a diverticulum, arising from the right wall of the bladder, equal in size to the bladder (Fig. 3). Chronic cicatricial urethritis was present, and there were 9 ounces (270 cubic centimeters) of residual urine.

At operation, September 23, 1930, a diverticulum, 7.5 centimeters in diameter, arising from the right wall of the bladder about 1.5 centimeters from the right ureteral orifice, was removed by extravascular excision. The postoperative course was normal for 21 days and the suprapubic wound was dry. On the twenty-second day there were chills and fever, which disappeared following drainage of the bladder by means of a catheter. Removal of the urethral catheter was followed with urinary retention and return of chills and fever, the patient became weak and the value for urea in the blood mounted to 214 milligrams in each 100 cubic centimeters. Vomiting and gastric retention were noted on the fortieth day after operation. The suprapubic tube was replaced, fluids were given by vein twice a day, gastric lavage was carried out twice a day and the value for blood urea returned to normal in 2 weeks.

The patient was sent home on the sixtieth day after operation, wearing a suprapubic tube, to return for operation on the vesical neck later. He was seen 2 months later, then his weight was returning to normal and he felt better, but the value for blood urea was still elevated to 76 milligrams in each 100 cubic centimeters. Operation was deferred.



Fig. 4. At left, large diverticulum equal to bladder in size; at right, two diverticula resected.

plication of the renal pelvis and of the ureter was found in 1 case. The great number of hernias present makes it appear that congenital weakness of the tissues has something to do with the development of diverticula, and that congenital anomalies may account for a smaller number. Multiple diverticula were found in 7 cases.

Types of obstruction at the vesical neck. Diverticula of the bladder in adults practically always are seen in the presence of obstruction at the vesical neck. This no doubt accounts for the fact that a very large proportion of the patients with diverticula are men. All of our patients were males. Judd, in 1924, reported a series of 133 cases, only two of which affected women. Thus, it appears that weakness of the musculature of the bladder either due to congenital defect or anomaly, together with the mechanical factor of obstruction, is the first cause of diverticula.

In more than half of our cases (17) definite fibro-adenomatous hypertrophy of the prostate gland made prostatectomy advisable as may be noted in Cases 4 and 5. However, the smaller the prostate gland appeared to be at operation, the longer the symptoms seemed to have been present.

A definite median bar (Cases 1 and 6) formed of the substance of the prostate gland itself or by inflammatory tissue was noted in 5 cases.

Cicatricial contraction of the vesical neck may occur (Case 3) and can be remedied by a plastic

procedure on the vesical neck at the time of diverticulectomy by a subsequent punch operation, or by incision with the Collings knife. There were 4 such cases in this series.

In cases in which there is a long history of difficulty and there is no evidence of prostatic hypertrophy or of a median bar, a chronic cicatricial posterior urethritis with obstruction of the vesical neck may be present (Case 2). In these cases excision or dilatation of the urethral structure is necessary for relief of symptoms. Four of our cases fell into this group.

OPERATIVE PROCEDURES

Excision of the diverticulum is the only operation which gives uniformly good results. The pouch-like structure, depending on its size, its accessibility or its situation, can be excised by one of three methods: (1) extravesical, (2) transvesical, or (3) intravesical. The operation that can be applied divides the cases into three groups.

EXTRAVESICAL EXCISION AND ILLUSTRATIVE CASES

Extravesical excision (Fig. 1) is usually applied to large diverticula that can be separated from the surrounding structures by careful dissection. It was employed in 10 of our cases.

The bladder is incised and the opening or neck of the diverticulum is found. The surrounding

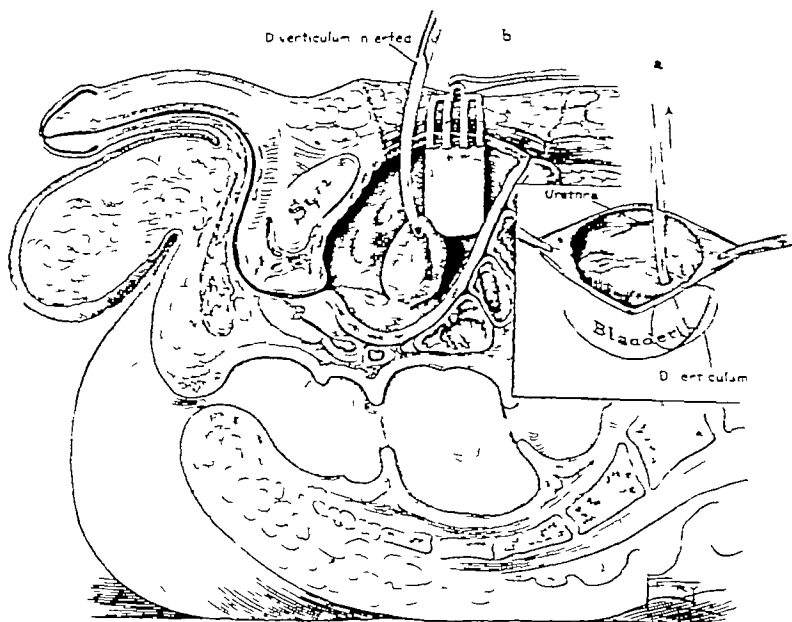


Fig 8 Intravesical removal of diverticulum of bladder. Insert shows method of grasping the fundus of diverticulum preparatory to inverting it into bladder.

did not empty. There was a stone in the diverticulum on the right side, and residual urine measured 3 ounces (90 cubic centimeters).

At operation, April 21, 1926, two small diverticula were noted at the base of the bladder. The right one contained a stone about 3 centimeters in diameter, which was removed. There was much pus in each diverticulum. The necks of the diverticula were widened and the bladder was drained. At a second operation, May 24, 1926, the diverticula were removed by an approach from within the bladder. Transvesical dissection was done and the bladder was again drained. June 16, 1926, at a third operation, suprapubic enucleation of the prostate gland was carried out. Chronic prostatitis and some adenofibromatous hypertrophy were present. The bladder was found to be clean at this operation.

Convalescence was uneventful. In a letter, received 4½ years afterward, the patient stated, "I am feeling fine and am working every day. There is no burning or frequency of micturition."

This case illustrates the excellent results of diverticulectomy, with secondary removal of an obstructing prostate gland.

CASE 5. A man, aged 66 years, had had frequency, burning, nocturia, and a slow stream for 15 years. He had had acute retention 12 years before his registration at the clinic. Arteriosclerosis was graded 3. Vesical dullness extended to the umbilicus, and there was 1,500 cubic centimeters of residual urine. A left inguinal hernia, and a small umbilical hernia were present. The proportion of erythrocytes in the urine was graded 3 and pus 2. Cystoscopic examination revealed cystitis of high grade, with many granulations. A diverticulum, of greater capacity than the bladder, arose from the left portion of its base.

May 23, 1928, the diverticulum, which was approximately 15 centimeters in diameter (Fig 7), was removed by extravesical dissection. A smaller diverticulum was noted on the right wall. The bladder was drained. June 13 this smaller diverticulum (7.5 centimeters in diameter) was resected by transvesical excision. The adenofibromatous prostate gland was enucleated at this time.

The wound healed with difficulty. Marked cystitis was treated by lavage and catheterization three times a day. A letter, received 2½ years later, contained the information that the patient was in good health, that he was passing a normal stream, and that he had no symptoms.

INTRAVESICAL EXCISION AND ILLUSTRATIVE CASE

This method, described by Young in 1906, like the one just mentioned, has its virtue in that the mucous membrane can be made to separate from the wall of the sac rather easily in some cases. The procedure is usually applicable to treatment of rather small diverticula. In cases in which infection is present around the sac, resort must be had to one of the two former methods.

The bladder is opened suprapubically and the orifice of the diverticulum is exposed. A pair of forceps is passed into the orifice of the diverticulum and the fundus is firmly grasped. Traction with the forceps is made toward the interior of the bladder and the sac is inverted (Fig 8) into the bladder. The sac is then cut off at the neck. The muscles are closed by interrupted sutures. The mucosa is then brought together over



Fig. 74. Huge diverticulum on left wall of bladder and smaller one on right. δ Diverticulum resected. It was equal to the bladder in size.

CASE 3. A man, aged 48 years, had noticed increasing frequency and nocturia for 3 years before his registration at the clinic. He also had difficulty in starting the urinary stream, straining on urination, and cloudy urine. Pus in urine was graded 3. The bladder was large, and the cystograms (Fig. 4) gave evidence of a diverticulum high in the median line, 6 and 8 centimeters in various diameters, when the bladder was empty, and apparently twice that size when it was distended. There was evidence of chronic prostatitis and there were 14 ounces (430 cubic centimeters) of residual urine.

January 6, 1936 two diverticula of the bladder were found at operation (Fig. 4). The larger lay posterior to the bladder and opened just posterior to the left ureteral orifice. This diverticulum had a capacity of about 6 ounces (180 cubic centimeters). The smaller diverticulum had capacity of 3 ounces (85 cubic centimeters) and was situated on the left lateral wall, with its opening about 5 centimeters lateral to the larger one. Both diverticula were removed by extravesical excision.

Convalescence was uneventful and the patient was dismissed from hospital on the twenty-eighth day after operation. The suprapubic sinus was healed at that time. Two weeks later chills and fever appeared and 5 to 6 ounces (150 to 200 cubic centimeters) of residual urine was obtained. A pouch operation was performed March 9, 1936 for constriction of the calical neck. Two months later the patient said that his health was excellent. One and half years later, he said that the urinary stream was of good volume and that it started without difficulty.

TRANSVESICAL EXCISION AND ILLUSTRATIVE CASES

If there is evidence of marked perivesical inflammation, if the bladder has been previously drained and much scar tissue is present, making extravesical dissection difficult and hazardous because of the possibility of opening the peritoneal

cavity and if the diverticulum is not too large, the transvesical method suggested by Genaghty is indicated. This type of procedure was applied in 5 of our cases.

The wall of the diverticulum is made up of two main layers. These are the mucosa, and an outer fibrous layer between which there are sometimes a few muscle fibers. The bladder is opened suprapubically as in the former method and good exposure of the diverticulum is obtained. A circular incision (Fig. 5) is then made around the neck of the diverticulum, through the bladder. The fibrous ring can be incised in either direction in order to facilitate manipulation in dissection. The entire diverticulum is removed by a process of sharp, combined with blunt, dissection (Fig. 5). The muscles of the wall of the bladder are brought together by interrupted sutures of chromic catgut, and the mucosa is sutured over this with plain catgut. A Penrose drain may be placed temporarily to the outer side of the bladder and a No. 30 catheter is placed in the bladder for suprapubic drainage and is left in place until further operation on the neck of the bladder is done to relieve any existing obstruction.

CASE 4. A man, aged 30 years, had had increasing frequency and nocturia for 3 or 4 years. He felt that the bladder did not empty and he had noted bloody urine. On examination, arteriosclerosis (graded), the prostate gland was palpated by rectum and was enlarged (graded). The amount of pus in the urine was grade 4. A cystogram (Fig. 6) gave evidence of a largely dilated bladder with diverticula on either side of several ounces capacity which

PRIMARY MALIGNANT NEOPLASMS OF THE EPIDIDYMISS

C A COLEMAN, M D, F A C S, J A MACKIE, A B, M D, AND WALTER M SIMPSON, M S, M D,
F A C P, DAYTON, OHIO

MALIGNANT tumors of the testicle are rare. According to Keller, who made a study of 28 cases in the Municipal Hospital at Copenhagen, they occur once in 15,000 cases. Apparently they are somewhat more numerous in America because in 300,000 cases admitted to the Mayo Clinic, 50 cases of neoplasm of the testicle were found (22). Primary malignancy of the epididymis is of even less frequent occurrence. In the literature we have been able to find reports of only 21 instances of malignant neoplasm which were considered to be primary in the epididymis. In view of this fact, we wish to present the clinical and pathological findings in a case of primary malignant teratoma of the epididymis.

Mr F H., aged 51 years, came to us on August 5, 1928, because of a swelling in the right side of the scrotum. A few days previously he had experienced a sense of heaviness in the right half of the scrotum and he stated that the right testicle seemed to be somewhat enlarged and slightly tender. He had never suffered any acute pain in that region, but the mental annoyance caused him to seek relief. He had no recollection of any injury to the scrotum. There were no symptoms referable to the gastro-intestinal, cardio-respiratory, or nervous systems. The family history was negative for tuberculosis, cancer, and syphilis.

The general physical examination showed no essential abnormalities.

The urological examination revealed a slightly enlarged right epididymis, of hard nodular consistence and moderately tender to pressure. The right testicle appeared to be normal in size, shape, and consistence. There was no fluid in the tunica vaginalis propria. The left testicle and epididymis were normal. Rectal examination showed the prostate gland to be slightly enlarged, freely movable, and smooth, the median commissure was almost obliterated. The expressed prostatic secretion contained only an occasional pus cell. There was no urethral discharge.

The urine showed a very faint trace of albumin, an occasional hyaline cast, and a few scattered separate pus cells. Numerous stained smears and animal inoculations failed to reveal the presence of tubercle bacilli. X-ray studies of the chest showed no evidence of active tuberculosis or metastatic neoplasm. The blood Wassermann and Kahn reactions were negative.

A tentative diagnosis of tuberculous epididymitis was made. The patient was admitted to the Miami Valley Hospital on August 25, 1928, at which time the operation was performed.

A longitudinal incision 7 centimeters in length, was made on the anterior portion of the right side of the scrotum. The right testicle and epididymis were delivered into the wound. There were no scrotal adhesions. The body of the epididymis was slightly enlarged, rather hard, and definitely nodular. The globus major of the epididymis was not involved. The testicle was smooth and of normal size

and consistence. The epididymis was easily separated from the testicle by passing a blunt hæmostat between them. The epididymis was removed from its testicular attachment by cautery. The vas deferens was ligated at the level of the external inguinal ring. The scrotal fascia was closed by No. 6 chromic catgut and the skin edges were approximated with metal skin clips.

Pathological examination. The microscopic examination of sections taken from the firm yellowish-white mass, measuring 5 by 3 by 2 centimeters, revealed a diffusely infiltrating neoplasm, in which the predominating cell type was a large, round, or spindle-shaped cell with pale, clear cytoplasm and a large, hyperchromatic nucleus. Scattered here and there were small deeply staining round cells of the lymphocytic type. The tubules of the epididymis were widely separated by the neoplasm cells. The histopathological diagnosis was malignant teratoma, composed of highly undifferentiated embryonal cells, this neoplasm possessed the histological characteristics of the so called embryonal carcinoma with lymphoid stroma. This teratomatous new-growth was structurally identical with the most common form of malignant neoplasm originating in the testis.

Sections were submitted to Aldred Scott Warthun, professor of pathology at the University of Michigan. Doctor Warthun's diagnosis was "Malignant teratoma, of the undifferentiated embryonal carcinoma type."

The patient was informed of the pathological diagnosis and a more radical operation was proposed but he refused to submit to any further treatment.

The postoperative convalescence was uneventful. The skin clips were removed on the seventh day and the patient was dismissed from the hospital on the tenth day following the operation.

Nothing more was heard of the patient until May 27, 1929, when he presented himself to Doctor E. R. Arn for a vague gastro-intestinal complaint and the loss of 15 pounds in weight. Examination at this time revealed a small grapefruit size, firm, nodular mass in the right upper abdominal quadrant. Because of the previous history, Doctor Arn made a diagnosis of metastatic malignancy of the retroperitoneal lymph nodes.

The general condition of the patient continued to pursue a downward course until the time of his death on July 6, 1929, about 10 months after the operation.

The pertinent findings at the postmortem examination follow.

The body was that of an undernourished, emaciated, senile appearing white adult male, looking much older than the stated age. The external examination revealed little of importance, except the presence of a completely healed linear scar 1 inch in length in the scrotum overlying the right epididymis. The spinal cord and brain were not examined because of stated restrictions.

The heart showed no essential abnormalities. Both lungs contained localized areas of terminal lobular pneumonia, there were multiple scattered healed tubercles. The bronchial lymph nodes contained many healed calcified tubercles.

The abdomen contained a large, firm, whitish retroperitoneal tumor mass which extended from the brim of the true pelvis to the inferior surface of the liver. The mass



Fig. 9. Small diverticulum of left wall of bladder

this row of sutures. A drainage tube for urine is placed in the bladder and the bladder is closed around it. Diverticula were removed by this method in 4 cases.

CASE 6 A man, aged 37 years, was found to have a marked pyuria. He had bilateral inguinal hernias, erythrocytes in the urine were graded 3, and pus 4. A cystogram (Fig. 9) gave evidence of smooth diverticulum of the left wall of the bladder. On cystoscopic examination this diverticulum appeared 1 cm. by 2.5 centimeters. Chronic prostatitis was present, and there was bar graded 2, at the neck of the bladder.

October 9, 1930, this diverticulum was pulled out the bladder (inverted) and excised, the median bar and posterior lobe of the prostate gland were removed. The supra-pubic tube was removed on the tenth day. The wound healed readily. October 28, 1930, bilateral herniorrhaphy was performed.

November 18 the patient was discharged from observation. At that time the urine was clear and the patient was feeling well.

RESULTS

In more than two-thirds of the cases in which the diverticulum was removed the results were good. In 3 cases the results were fair the patients were relieved of most of the troublesome symptoms. Five patients continue to complain of dysuria. The latter group consisted of the case

in which the vesical necks were the site of inflammatory cicatricial change, with or without accompanying posterior urethritis. Removal of a portion of this sclerosed vesical neck by the punch operation did not always serve immediately to relieve the urinary retention, possibly because of the surrounding inflammatory tissue and possibly because there may have been some fundamental abnormality of neuromuscular control of the bladder. This group included most of the younger men.

The best results occurred in those cases in which the obstruction at the vesical neck was thoroughly removed, either at the time of diverticulectomy or subsequently. In other words, patients with associated hypertrophy of the prostate gland who underwent prostatectomy, obtained the best results. Similar results occurred in most cases in which a punch operation for obstructing median bar was performed.

CONCLUSIONS

Diverticula of the bladder are being found with increasing frequency. Surgical treatment consists of their removal. Successful relief of symptoms after diverticulectomy is dependent on the completeness of removal of obstruction at the vesical neck.

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This increased in size and became painful and when first seen by the surgeon had reached the proportions of a walnut in the region of the globus major and was accompanied by a smaller tumor in the globus minor. The testicle and both masses were tender. Biopsy revealed the tumor to be round cell sarcoma. Castration was done. A new growth the size of a marble attached to the posterior surface of the globus major was removed. The vas deferens was also infiltrated. Microscopically, there was an infiltration with small round cells. In places these appeared to be undergoing organization but a combination of the clinical and histological characteristics appeared to favor malignancy.

CASE 3. Kocher and Langhans. A man aged 50 years was operated upon 3 weeks after he first noticed an enlargement of the scrotum associated with drawing pains. At this time a hard, firm epididymis could be palpated behind a normal testicle. Two months after the initial operation, castration was done. Soon after this, he developed metastasis to the nerve centers and later to the skin and lungs. Death occurred shortly after the appearance of metastatic lesions. The diagnosis was primary sarcoma of the tail of the epididymis.

CASE 4. Kocher and Langhans describe a case of melanoma sarcoma originating in the tail of the epididymis. This growth later invaded the testicle. No further history was given.

CASE 5. Kocher and Langhans report a case of cystosarcoma of the epididymis. This consisted of a very thick walled cyst in which the epididymal canals could be seen between the new formations of round cells. The testicle rested on the mass but was macroscopically normal. No further history was given.

CASE 6. Rydygier. A 42 year old physician noticed a pea-size swelling in the epididymis. As this was associated with drawing pains in the pelvis he demanded a castration. This was immediately done. The swelling was found to have arisen from the head of the epididymis. The growth measured 1.5 by 1 centimeter. Microscopically it showed the characteristics of a typical melanoma sarcoma. The cells were spindle shaped and were in some places filled with a black brown pigment. The epithelium of some of the seminal ducts was invaded while many others remained normal. Four weeks after the operation the patient returned and demanded the removal of the remaining testicle because he felt a nodule there. This operation was done and the pathologist reported a brownish pigmentation of the epithelial cells of the epididymis. However, this epididymis apparently was not sarcomatous.

CASE 7. Bazy (2). A man aged 48 years had noticed some enlargement of one of his testicles ever since the development of gonorrheal epididymitis 25 years previously. Two months before admission he received an injury to the testicle and after that time it increased rather rapidly in size. On admission it was the size of a goose egg, pear shaped, and of firm consistence except in one spot where there was fluctuation. The glands of the abdomen were not enlarged. The testicle and epididymis were removed, and the body of Highmore and the epididymis were found to be the seat of a small round cell sarcoma. The remainder of the testicle was normal. A subsequent report (3) states that the growth probably arose in the rete testis and from there invaded the epididymis but not the testicle.

CASE 8. Kolster. A farmer 52 years of age came to the clinic because of dyspnea. A diagnosis of malignant tumor of the mediastinum was made. The autopsy showed a round cell sarcoma of the epididymis with metastasis to the lymph nodes of the left inguinal region, the nodes along the left side of the spine, the left lung, the liver, and

the cardiac end of the stomach. One mass in the left lumbar region was as large as a child's head and another mass in the mediastinum passed up under the left sternomastoid muscle into the left supraclavicular fossa where it reached the size of a goose egg. The left testicle was entirely normal. The primary growth and the metastatic nodules all showed the structure of a round cell sarcoma.

CASE 9. Russell and Wood. A boy aged 15 had had three definite injuries to the left testicle. When first seen he had a boat-shaped tumor about 4 inches in length in the region of the left testicle. About 1 week later a nodule appeared in the upper portion of the growth and fluctuation was noticed. Two days later the tumor was removed. It was kidney shaped and weighed three fourths of a pound. The testicle was located behind the mass and was found to be normal. Microscopic sections showed the new-growth to be composed of large and small round cells and spindle cells. The connective tissue stroma was arranged in bundles and whorls.

CASE 10. Grasman. A man aged 42 years received a crushing injury to the left testicle 6 months prior to admission. Three months later he developed a swelling which gradually increased in size until it was as large as a man's fist. It was smooth, tense, elastic, and was associated with a small hydrocele. At operation a sarcoma of the epididymis was found. The testicle was normal except for the signs of compression. There was no recurrence 1 year later.

CASE 11. Wrobel reports the case of a man aged 24 years. Two years before admission he had arthritis complicated by heart trouble. Eighteen months later he experienced a recurrence of gonorrhea. A short time before admission he noticed a swelling of the left testicle. This was accompanied by pricking pains. The epididymis and testicle contained nodules, some of which were as large as a hazelnut. The spermatic cord was similarly involved. Castration was done and the microscopic examination showed carcinoma of the epididymis. Death occurred about 12 years later but the cause of death is not mentioned.

CASE 12. Miyata. A 32 year old man noticed a swelling of the left side of the scrotum 3 weeks before admission. The testicle was considerably enlarged, hard, and slightly tender. There was no swelling of the glands. The condition was diagnosed as chronic epididymitis and castration was performed. The pathological examination showed the testicle to be normal but there was a soft, juicy, encapsulated tumor about the size of a pear on the epididymis. The microscopic diagnosis was sarcoma.

CASE 13. Spandri. A man aged 80 years noticed a sense of heaviness in his right testicle about 1 year before admission. This disappeared under treatment but 11 months later he developed pain in his testicle, associated with swelling. When first seen, the scrotum was enormously enlarged. The tumor was smooth and of firm consistence, posteriorly. The tumor, spermatic cord, testicle, and epididymis were removed. The testicle was not involved. The epididymis was about three times normal size and was made up of a hard, compact elastic tissue, except in areas where it was opaque and of a yellowish color. Microscopically the form and arrangement of the cells, the abundant blood supply, the absence of epididymal tissue in these masses, and the presence of cartilage indicated that this growth was a chondrosarcoma.

CASE 14. Colby describes a case of columnar carcinoma of the epididymis occurring in a 32 year old man. When first seen the left globus major was slightly enlarged but distinct from the testicle. Six weeks later the globus major had increased in size and the globus minor was invaded but the testicle remained normal. The involvement in-

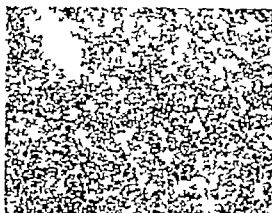


Fig. Photomicrograph of primary embryonal carcinoma of right epididymis, showing tubule of epididymis in upper left quadrant of photomicrograph. The neoplasm cells, showing pale clear cytoplasm and large hyperchromatic nuclei are seen, together with the characteristic lymphoid stroma.



Fig. 2. Photomicrograph of tissue from right testicle, adjacent to site of the primary neoplasm of the epididymis, showing atrophy and vacuolization of the germinal epithelium with spermatogenesis. There is no evidence of testicular neoplasm.

was made up of enormously enlarged retroperitoneal lymph nodes. Completely surrounded by the mass were the right kidney and adrenal, the head of the pancreas and the abdominal aorta. Just below the head of the pancreas, the mass assumed the size of a large grapefruit (5 by 12 by 9 centimeters). The liver showed fatty infiltration, marked cloudy swelling and congestion, but no evidence of neoplasia. The neoplastic mass surrounding the right kidney had extended to but not through the fibrous capsule. The kidneys showed marked cloudy swelling but no evidence of neoplasia. The right ureter was partially obstructed by the neoplastic mass with the result that the renal pelvis was dilated to about twice the normal size. The aorta showed slight atherosclerosis, there was no evidence of atherosclerotic aortitis.

There were no penile scars. The right testicle was banded to the healed surgical incision by many adhesions. There was no gross evidence of neoplasm of either epididymis or either testicle. The prostate gland was about one and one-half times normal size and showed localized per-acute areas of glandular hyperplasia on either side of the prostatic urethra.

Microscopic examination of tissues from the greatly enlarged retroperitoneal lymph nodes showed the same type of neoplasm as was found in the mass removed from the right epididymis 9 months previously. There was no macroscopic evidence of neoplastic invasion of the parenchyma of the right kidney, right adrenal, and body of the pancreas.

Serial sections of the remaining portion of the right epididymis showed no evidence of recurrence of the neoplasm. The testicles showed atrophy and vacuolization of the germinal epithelium with spermatogenesis. The tunica albuginea of the right testicle showed no neoplastic infiltration.

Microscopic studies of lung tissue showed localized areas of acute terminal lobular pneumonia with small localized areas of completely healed fibrinoid tubercles.

The pathological diagnosis was: Advanced retroperitoneal metastatic carcinomatosis, involving all of the retroperitoneal lymph nodes, with direct extension of the neoplasm to the capsules of the right kidney and right

adrenal, right ureter, head of pancreas, and abdominal aorta. (Primary malignant testis, embryonal carcinoma type, removed surgically 9 months previously.) Right obstructive hydrocephalus. Acute terminal bilateral per-acute lobular pneumonia. Healed pulmonary and bronchial node tuberculosis. Early atherosclerosis. Passive congestion and cloudy swelling of all organs. Cachexia.

The essential features of this case are concerned with the development of a primary malignant teratoma in the right epididymis. The neoplasm was of the type generally considered to be an undifferentiated embryonal carcinoma. This type of neoplasm commonly originates in the testicle. The postmortem examination revealed no evidence of testicular origin of the neoplasm in this case.

PREVIOUSLY REPORTED CASES

A review of the world's literature reveals that only 21 authentic cases of primary malignancy of the epididymis have been reported. Abstracts of the previously reported cases follow:

CASE 1. Lewis and Jacobs reported the pathological examination of specimen A. Clinical history was given. The epididymis was destroyed or replaced by a neoplasm which, on section, showed numerous small cysts filled with thick yellowish matter and clusters of hyaline cartilage. The cysts were lined with transitional epithelium. The testicular matter was composed of median sized, rounded corpora embedded in homogeneous matrix. The testicle was normal except for degeneration of the epithelial elements.

CASE 2. Edwards reports the case of a man aged 30 years whose general health had always been excellent until 8 months previously when he developed gonorrhea. One year later he had rheumatism. Six weeks before admission he noticed pea-size nodules just above the left testicle.

neoplasm cells to spermatocytes Chevasu expressed the belief that these cells were derived from the epithelial cells of the seminal tubules He gave to these neoplasms the name "seminoma" Many other investigators, notably Tanner, Nicholson, Debernardi, and Southam and Linell, have referred to these neoplasms as seminomata or spermatocytomata

The microscopic studies made in the case which forms the subject of this communication reveal the same type of neoplasm as that which commonly arises in the testicle and to which the names seminoma or spermatocytoma have been applied The fact that this neoplasm had its origin in the epididymis without evidence of any neoplasm in the adjacent testicle would seem to argue against the possibility that such neoplasms have their origin from the germinal epithelium

Most pathologists are in agreement with Ewing, who states that all of the common neoplasms of the testis are of teratomatous nature, in which one type of tissue usually predominates, to the exclusion of the other teratomatous tissue elements In many of the neoplasms which have originated in the testicle or epididymis a multiplicity of tissue elements derived from the three germ layers, such as cartilage and bone, skin and accessory skin structures, smooth muscle tissue, fat tissue, brain tissue, placental tissue, remnants of the alimentary or respiratory tract, thyroid tissue, indicate indisputably the teratomatous origin of such neoplasms Hinman, Gibson, and Kutzmann (15) have found various types of tissue associated with areas of so called spermatocytoma tissue, these authors conclude that "the term 'seminoma' or 'spermatocytoma' must, therefore, be regarded as a misnomer, and the contention of Chevasu is disproved in favor of Ewing's theory" It seems probable that the great majority of cases of primary malignant neoplasm of the testicle and epididymis which have been designated as sarcomata are in fact embryonal carcinomata The large, spheroidal, spindle-form cells which constitute the essential element of these neoplasms bear a close morphological resemblance to sarcoma cells True sarcoma of the testicle or epididymis is probably of rare occurrence, Dew's studies lead him to believe that only about 2 per cent of such neoplasms should be regarded as sarcomatous

The embryonal carcinoma of the testis or epididymis is a rapidly growing neoplasm In most instances it tends to reach a large size within a short time Extensive necrosis of the neoplasm cells with hæmorrhage, ulceration, and suppuration is not uncommon In most instances metas-

tasis occurs relatively early The most extensive early metastasis occurs along the spermatic lymphatics to the lumbar retroperitoneal lymph nodes Ultimately, the entire chain of retroperitoneal lymph nodes shows extensive metastasis In some cases metastasis may involve the tracheomediastinal and cervical lymph nodes Discontinuous venous metastasis is frequent with the establishment of metastatic tumors in distant viscera

The embryonal carcinoma of the testis or epididymis is one of the most malignant of all neoplasms The prognosis is particularly unfavorable in young individuals

TREATMENT

In view of the fact that metastasis occurs relatively early in these cases, the removal of the testicle, epididymis, and spermatic cord structures is usually of no avail Hinman (13) has proposed a more radical operation in which, in addition to these procedures, the retroperitoneal and lumbar lymph nodes and lymph channels are dissected away In the report of the first 46 cases treated in this manner, the operative mortality was 11 per cent In a later report, Human (14) states that he has obtained cures in 30 per cent of 79 cases in which the radical operation has been carried out Cairns (5) reported 74 cases from the London Hospital, 55 of these patients were subjected to simple orchidectomy, while 19 had the radical operation There was no operative mortality Thirty-three per cent of the patients on whom orchidectomy was done were said to have recovered, while 31.2 per cent of the patients who had the radical operation were said to have recovered

The majority of investigators incline to the belief that orchidectomy followed by radium or roentgen therapy offers the greatest hope The embryonal carcinoma appears to be unusually radiosensitive Higgins and others have recommended primary treatment with X-ray or radium, to be followed by orchidectomy, which, in turn, is to be followed by a prolonged course of X-ray or radium treatment

SUMMARY AND CONCLUSIONS

- 1 The clinical and pathological findings in a case of primary malignant teratoma (embryonal carcinoma) of the epididymis are presented

- 2 This neoplasm corresponded structurally to the most common form of malignant neoplasm originating in the testicle The origin of this neoplasm in the epididymis renders invalid the theory that such neoplasms have their origin in the spermatoblasts of the germinal epithelium

crossed steadily and it became impossible to say which portion of the testicle was involved. At this stage the skin and the spermatic cord were lowered. Castration was done and the specimen was found to be cystic. The microscopic examination showed columnar cell carcinoma. The patient was dismissed from the hospital and was not seen again for 9 months. At this time there was a mass about the size of a fetal head in the left hypochondrium. From this time he became steadily worse and death occurred 2 months later. Postmortem examination showed the abdomen to be filled with a single, smooth, elastic tumor which was cystic and friable and about the size of an association football. The origin could not be determined. Coffy states that he believes carcinoma of the testicle frequently arises in the epididymis.

CASE 15. Rowlands and Nicholson. A 45 year old policeman suffered from a painful enlargement of the right testicle. This organ was always slightly larger than its mate, but following an injury 4 months before admission it gradually increased in size and became painful. At the time of admission there was moderate enlargement of the right side of the scrotum. Anteriorly the swelling was smooth, soft, and translucent but posteriorly it was hard and somewhat irregular. In the latter position the enlarged epididymis could be felt. The testicle was not involved. There was slight thickening of the spermatic cord. Two weeks after admission the testicle, epididymis, and spermatic cord were removed. The wound healed by first intention. Nine days after operation edema of the right leg was first noticed. The patient developed sepsis and abdominal pain, death occurred about 7 weeks after operation. No autopsy was obtained. Microscopically the specimen obtained at operation revealed squamous cell carcinoma of the epididymis, tunica vaginalis, and a smaller nodule in the spermatic cord.

CASE 16. Mund-Sutton. A man aged 3, first noticed enlargement of his testicle 8 months before admission. Since that time it gradually increased in size. The testicle, epididymis, vas deferens, and one lymph node were removed. The enlarged lymph node was situated in front of the vena cava on a level with the third lumbar vertebra. The tumor was found to be cystic and to occupy the space between the testicle and the epididymis. Microscopically the tumor was composed of intercommunicating tubules imbedded in a connective tissue stroma. In places hyaline cartilage was present and in other places those resembling cartilage were found. The tubules were lined with epithelium some of which was stratified and some of which was columnar. The enlarged lymph node was cystic and was in some places lined by columnar epithelium. Mund-Sutton regarded this neoplasm as a malignant teratoma.

CASE 17. Sakaguchi. An 8 year old youth first noticed some swelling of the left testicle 14 weeks before operation. This swelling was associated with a varicocele. At the first operation the varicocele and as much as possible of the epididymis was removed. As the diagnosis was carcinoma a secondary castration was performed 3 days later. A short time after this the patient was dismissed from the hospital. He remained well until 9 months after the operation at which time he developed vague pulmonary symptoms. Tubercle bacilli were found and the patient gradually grew worse and died about 5 months after the onset of pulmonary symptoms. Autopsy showed extensive metastases to both lungs and to the retroperitoneal and mediastinal lymph nodes.

Microscopic examination revealed carcinoma which the author considered to have arisen in the epithelium of the capsule of the epididymis.

CASE 18. Barringer reports the case of a man who presented upon examination an enlargement of the right

epididymis and a fairly large abdominal mass. The primary tumor was story hard and somewhat irregular. At operation the spermatic cord was found to be thickened and one of its vessels ran into the abdominal mass. The tumor was treated by radium but the results are not given. The testicle and prostate were perfectly normal. The condition was diagnosed as teratoma of the epididymis.

CASE 19. LaPointe and Coffy. A man, aged 68 years, had experienced pain in the left testicle for 3 years. Examination revealed a tumor of cherry seed size in the tail of the epididymis. This was slightly nodular and had the consistency of a slightly thickened cyst. At first this was thought to be the result of gonorrheal epididymitis which he had 43 years previously but, because of pain, castration was done. The tumor was made up of irregularly shaped cellular groups in connective tissue which was unaltered except for slight lymphocytic infiltration. In some places the cells were elongated and gave the appearance of spindle cell sarcoma but there were no embryonic blood vessels present. In other places the cells were pleomorphic in form and were arranged in regular series, thereby giving the appearance of a basal cell epithelioma. There was no evidence of embryonic connective tissue and there did not appear to be any transition between the cytologic cells of the normal epithelium and the neoplastic cells. The growth was believed to be a case of epithelioma arising from the basal cells of the epididymis. The patient was well one year after the operation.

CASE 20. Higgins and Gibson (10). In a man, 73 years of age, a nodular mass appeared in the left side of the scrotum, months before admission. This was accompanied by slight drawing sensation. Examination showed the epididymis to be nodular and of a hard rubbery consistency. The skin was adherent. No inguinal glands could be palpated. Operation revealed the tumor to be primarily in the body of the epididymis. It was adherent to the skin, the median septum, and the head of the left corpus cavernosum. Epididymectomy was performed.

Microscopically the tumor was composed of fibrous tissue in which were imbedded numerous acid fast nodules by epithelial cells. The basement membrane was lacking in some places. The consistency of epididym was that this growth was an adenocarcinoma of low-grade malignancy. The patient was well 8 months following operation.

CASE 21. Scholl and Verbruggen report the case of a 21 year old man who, 14 months previously, had received severe kick in the right testicular region. Three months later the testicle became painful and for 6 months before admission steadily increased in size until it reached twice the normal size. During this time he lost 15 kilograms in weight. Examination showed a hard, nodular epididymis associated with hydrocele. At operation, the testicle, epididymis, vas deferens, and their coverings were removed. Three months later he returned with a mass of 5 centimeters in diameter at the lower angle of the incision. This was removed and X-ray treatment was given. Four months later he returned and at this time showed signs of pulmonary involvement.

Microscopically the epididymis showed fibrous tissue framework containing numerous spaces filled with atypical epithelial cells arranged in an adenocarcinomatous manner. The testicle was not involved. The vas deferens was involved in certain areas.

The origin of malignant neoplasms of the testicle and epididymis has been a subject for great controversy. One of the outstanding contributions to this subject was made by Chevrin who pointed out the resemblance of the large clear

EDITORIALS

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JULY, 1932

CARL LANGENBUCH AND THE FIRST CHOLECYSTECTOMY

THE fiftieth anniversary of the first cholecystectomy will be celebrated on July 15, 1932. Carl Langenbuch performed the first operation in 1882, and his name has been permanently engraved thereby in medical history.

The events leading to the first cholecystectomy arose in the preliminary work of Teckof who first removed the gall bladder of a dog in 1667. Ettmueller repeated Teckof's work in 1670, and Herlin one hundred years later confirmed Teckof's observations by the removal of the gall bladder in cats. Joenissius had removed stones from a biliary fistula in 1676, and Vogel and Bloch in 1774 sectioned a biliary sinus to remove some calculi. Recamier in 1826 introduced a trocar into the gall bladder for drainage purposes, and in 1849 he repeated this operation successfully. In 1858 Santopadre performed the first cholelithotripsy.

Jean Louis Petit in 1743 performed the first cholecystostomy through adhesions which he had artificially created, and in 1867 Bobbs performed the first cholecystotomy. Bobbs'

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JULY, 1932

CARL LANGENBUCH AND THE FIRST CHOLECYSTECTOMY

THE fiftieth anniversary of the first cholecystectomy will be celebrated on July 15, 1932. Carl Langenbuch performed the first operation in 1882, and his name has been permanently engraved thereby in medical history.

The events leading to the first cholecystectomy arose in the preliminary work of Teckoff who first removed the gall bladder of a dog in 1667. Ettmueller repeated Teckoff's work in 1670, and Herlin one hundred years later confirmed Teckoff's observations by the removal of the gall bladder in cats. Joemsius had removed stones from a biliary fistula in 1676, and Vogel and Bloch in 1774 sectioned a biliary sinus to remove some calculi. Recamier in 1826 introduced a trocar into the gall bladder for drainage purposes, and in 1849 he repeated this operation successfully. In 1858 Santopadre performed the first cholelithotripsy.

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Langenbuch reasoned that as some humans had been born without a gall bladder, and as the elephant and horse do not normally possess this organ, the removal of the gall bladder in man should not be injurious. Therefore as there was no physiological contra-indication to the operation, he developed an operative method by studies upon six cadavers. Langenbuch finally evolved a technique and recommended exploration of the abdominal cavity through a T-incision, the horizontal bar being a transverse incision through the upper part of the right half of the abdomen while the longitudinal incision followed the outer border of the right rectus muscle. Each incision varied from 10 to 15 centimeters in length. The colon and the intestines were pushed downward by means of a large, flat sponge. The right lobe of the liver was raised through the abdominal wound until it protruded. The under surface of the liver was then secured between the fingers of the left hand and the gall bladder was identified with the right. The gall bladder was then freed from the liver by blunt, finger dissection and silk ligatures were applied around the lower end of the gall bladder somewhat above the cystic duct. This

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multiplicity of operations performed upon the gall bladder about Langenbuch's time are receding in popularity, but Langenbuch's operation of cholecystectomy remains steadfast, if not indeed the established and preferred operation

Langenbuch's life and his greatest achievement, i e , his cholecystectomy, furnish us an excellent example of the progress that personal character and painstaking experimental work produce in the development of new methods in surgery STANLEY H MENTZER

was accomplished after exposure of the neck of the gall bladder by knife and scissor dissection of the peritoneal coat. The section was then made between ligatures. Langenbuch stated that if the gall bladder was full it could be emptied by aspiration to prevent possible rupture or injury to the sac during cholecystectomy. The abdominal wall was then closed, layer by layer.

On July 15 1882 Langenbuch performed the first operation upon man. The patient was a 43 year old male upon whom extreme precautions were taken to assure asepsis. The operation was carried out as described and the patient got along very well. Two days after the operation he began to take liquid diet and twelve days after the operation he left his bed to be dismissed from the hospital about six weeks later. One of the most interesting observations in relation to his first cholecystectomy was his statement that he removed rather than drained the gall bladder not only because it contained stones but because it was the type of gall bladder in which stones would re-form.

The performance of the first cholecystectomy leads one to inquire into the life of the great man who first evolved this operation. Carl Langenbuch was born on April 30 1846 at Kiel. He studied at Kiel and Berlin and graduated from the latter city in 1869. Immediately thereafter he went to the Franco-German war for a short period and came home as assistant to Schuler von Willms in Bechaniën under whom his surgical training was developed. When only twenty-seven years of age he was made surgical assistant at the Lazarus-Krankenhaus in Berlin where he remained until his death, and in which place he laid the foundations of his versatile and varied career. It is no wonder that he loved this hospital in which he practiced his art for it was here that he developed his reputation which

brought credit not only to himself but also to his hospital. Indeed it is largely through him that the Lazarus-Krankenhaus became the greatest in Berlin. Langenbuch's vision was extensive and his work produced a widespread influence upon the surgical world. At the age of forty five he published a "Clinical Treatise on Surgery of the Liver and Gall Bladder" which became the handbook and standard work in this subject.

Early in 1880 he began to section peripheral nerves and even trunks in the spinal cord for tabes and he performed a considerable amount of experimental work in relation to this disease. He resected a large part of the liver for carcinoma (the piece weighing 400 grams) and he performed a laryngotomy in 1880. In 1886 he went to the Russo-Turkish war against Bulgaria where he became an ardent military surgeon and where he developed the specialty of veterinary surgery. He published works on the stretching of nerves, on diseases of the spinal cord, the treatment of gall stones, the treatment of severe hemorrhage by the application of zinc chloride, and numerous works upon military and veterinary surgery. He was without fear as a surgeon and he had an unusual grasp of the symptoms necessitating operative interference.

He possessed a gentle and timid nature but had a quiet jocularity that endeared him to everyone. He cultivated an interest in politics and had a natural curiosity for things of a social character. He was extremely patriotic and had musical inclinations which balanced and protected him from the one-sidedness of medicine. He lived happily and, fortunately long enough to enjoy the admiration of his colleagues for the excellent and unusual work that he had done. In like manner he lives in the memory of the present day probably glorified more now than before, and rightfully so for time has proved the merit of his work. The



MEMOIRS

WILLIAM WILLIAMS KEEN

JANUARY 10, 1837—JUNE 7, 1922

I believe in God and in Evolution. To all sincere seekers after truth—who revere the Bible as the word of God—who revere nature as the work of God—and who believe that rightly interpreted they must surely agree. To develop great men—and then by death to quench them in utter oblivion would be unworthy of Omnipotence. To my mind it is simply an impossible conclusion. Man's soul *must* be immortal. W. W. Keen.

THE death of this eminent surgeon—the lover of his personal God, a patriotic fighter for his beloved country who wore its uniform in two wars (in the Great War at the age of eighty years)—has brought the whole thinking world to attention in admiration of a fine and useful life and the profession of medicine mourns with deep sorrow the passing of a beloved comrade. His was a devoted service of seventy years in the practice of the great learned profession—scientific medicine. He was an ardent supporter of every moral, scientific and progressive advance in civic, state, and national affairs.

The American College of Surgeons and its official journal *Surgey Gynecology and Obstetrics* acknowledge a personal loss. Dr. Keen was the first surgeon of our country to accept and have conferred upon him an Honorary Fellowship in the College. He contributed to many of its scientific meetings, and lent his inspiring presence at numerous of its annual sessions. He was an early subscriber and a frequent contributor to the columns of the Journal. In the Great War—the eldest member of the Medical Reserve Corps—he was a personal friend. By his pen, his personal contacts, his orations and his friendly advice he was an inspiring aid to those of us who had to do with enrollment for war.

During his span of life—ninety five years—his was the rare privilege of witnessing and participating in every advance in surgery and of knowing all of the great men in medicine of his day. He began his medical studies in the Fall of 1860, and graduated in March, 1862. He early declined to be a champion of the Past but assumed the rôle of “a Herald of the Dawn.” In 1922 in his oration delivered on the occasion of the conferring upon him of the Bigelow Medal he took as his theme *Sixty Years of Surgery*. He compared the poverty of knowledge

and meagerness of resources in the 60's with the wealth of both in 1922, and said he wished he could "return in 1982 to converse with the Bigelows, the Grosses, the Mayos, the Flexners, and the Lovetts of that wonderful day" The first operation he ever saw was the removal of an upper jaw by Joseph Pancoast, and his first operative case—in the days of the Indian wars—removal of an arrow which had penetrated deeply just below the left eye He was office student of Jacob DaCosta and John Brinton while he studied at Jefferson Medical College

Sworn into service as assistant surgeon in Washington, July 4, 1861, he witnessed actual warfare in the Battle of Bull Run Just after the Civil War he was a pupil in Paris of Pouchet, son of Pasteur's opponent In 1865 he was a pupil in Virchow's laboratory On the occasion of Lister's visit to Philadelphia in 1876, Keen became fully converted to Lister's views

Keen's course of lectures at Jefferson on *Pathological Anatomy* in 1866-1867 was the first ever given in Philadelphia The first official course in surgical pathology was authorized in 1897 In the 60's assistants in the dissecting room often came directly to the surgical clinics to assist in operations Pancoast, Gross, and all others "operated in discarded, blood-stained coats, the veterans of a hundred fights" The teaching faculty consisted of seven professors and one demonstrator—anatomy There were no ward classes At Jefferson, they had two rooms, with five or six beds each, for the most serious cases

The first laboratory of research in the United States was established in 1884 As late as the 80's there were in most hospitals no trained nurses The first clinical thermometer he ever saw was brought to him from London in 1876 by Weir Mitchell Of the blood, knowledge was most primitive The electrocardiograph was not even a dream, no radium and no X-rays, no knowledge of test meals Until the 80's or 90's, smallpox was the only enemy combated by vaccination There were no serums, and no knowledge of how to prevent tetanus, diphtheria, malaria, yellow fever, and other diseases The real cause of tuberculosis was not known until 1882 Protective measures for the well were not even thought of, there was no knowledge of bacteria and bacteriology Vaccination, anæsthesia, and antisepsis (including bacteriology), Keen rated as "the three greatest blessings in the realm of medicine conferred on man since the Christian era began," and Lister's genius in applying Pasteur's discoveries to surgery "wrought the greatest revolution surgery has ever witnessed"

Nothing was known of endocrine glands and their important functions, nor of hormones and their mechanism There was no Schick test, Noguchi test, Pirquet test, Wassermann reaction, etc Nothing was known of the spread of diseases by the fly, the flea, the mosquito, the louse, the rat, and the cattle tick So-called sanitation was ineffective, because bacteria were unknown

In the operative surgery of Keen's surgical youth he listed amputations, ligation of arteries, occasional excision of joints, removal of external tumors,

William Williams Keen was born in Philadelphia, January 19, 1837, the son of William W. and Susan (Budd) Keen. In 1867, he married Emma Corinna Borden, of Fall River, Massachusetts, who died in 1886. His children, all of whom survive him, are Corinne (Mrs. Walter J. Freeman), Florence, Dora (Mrs. George W. Handy), and Margaret (Mrs. Howard Butcher, Jr.).

Degrees received include A.M., Brown University, 1859, M.D., Jefferson Medical College, Philadelphia, 1862, Sc.D., 1912, LL.D., from Brown in 1891, Northwestern and Toronto in 1903, Edinburgh in 1905, Yale in 1906, St. Andrews in 1911, and Pennsylvania in 1919, Ph.D. from the University of Upsala in 1907, Sc.D. from Harvard in 1920, Doctor, *honoris causa*, University of Paris, 1923.

After study in Europe during 1864-1866, he established himself in practice at Philadelphia. During 1866-1875 he conducted the Philadelphia School of Anatomy, lecturer in pathological anatomy at Jefferson Medical College, 1866-1875, professor of artistic anatomy, Pennsylvania Academy of Fine Arts, 1876-1889, professor of surgery, Woman's Medical College, 1884-1889, professor of surgery, Jefferson Medical College, 1889-1907, and professor emeritus from 1907.

Assistant surgeon U.S. Army in 1861, and acting assistant surgeon 1862-1864. He volunteered for the Spanish-American War, but owing to its short duration, his services were not required, 1st Lt., M.R.C., U.S.A., 1909, major, 1917-18. Member of the National Research Council 1917-18.

Charter trustee, Crozer Theological Seminary, from 1867, trustee and fellow, Brown University, from 1873, president, American Surgical Association, 1899, American Medical Association, 1900, College of Physicians, Philadelphia, 1900-1901, International Congress of Surgery, Paris, 1920 (the first American to hold the office), Congress of American Physicians and Surgeons, 1903, American Philosophical Society, 1907-1917, honorary fellow, Royal College of Surgeons of England, Edinburgh, Ireland, Italian Surgical Society, American College of Surgeons, associate fellow, American Academy of Arts and Sciences, honorary fellow, Boston Surgical Society (awarded Bigelow gold medal), awarded Colver-Rosenberger medal of honor, Brown University, gold medal by Pennsylvania Society of New York. Officer, Order of the Crown of Belgium, 1920, officer, Légion d'Honneur, France, 1923, member, Founders and Patriots of America, Loyal Legion, Medical Veterans of the World War, Sigma Xi.

Author of *Reflex Paralysis, and Gunshot Wounds and Other Injuries of Nerves* (both with Weir Mitchell and Morehouse), 1864, *Keen's Clinical Charts*, 1870, *History of the Philadelphia School of Anatomy*, 1874, *Early History of Practical Anatomy*, 1870, *History of the First Baptist Church of Philadelphia*, 1898, *Surgical Complications and Sequels of Typhoid Fever*, 1898, *Addresses and Other Papers*, 1905, *Animal Experimentation and Medical Progress*, 1914, *The Early Years of Brown University, 1764-1770*, 1914, *Either Day Address*, 1916, *Treatment of War Wounds*, 1917, *Surgical Operations on President Cleveland*, 1917, *Colver Lectures at Brown University on "Medical Research and Human Welfare,"* 1917, *Selected Papers and Addresses*, 1922. Editor Heath's *Practical Anatomy*, 1870, *Diagrams of the Nerves of the Human Body*, by W. H. Flower, 1872, *American Health Primers*, 1879-1880, *Holden's Medical and Surgical Landmarks*, 1881, *Gray's Anatomy*, 1887, *American Text-Book of Surgery*, 1892, 1903, *I Believe in God and in Evolution*, 1922, *Everlasting Life*, 1924, *Keen's System of Surgery*, 1906-21.

For much of the material contained in the above sketch, I am indebted to Dr. Keen's writings, to William Williams Keen by Wilfred Pickles, M.D., of Providence, Rhode Island (*Rhode Island M. J.*, 1927, x, pages 1-10), and to *Who's Who in America*.

ovariotomy, cutting for stone in the bladder. Gall stones were first removed from the gall bladder by Bobbs, of Indianapolis, in 1867. Gout operations were infrequent. Ophthalmology and the other specialties were just becoming visible. Surgery of the head, the chest, and the abdomen was rare. The cause of appendicitis was not known until 1886. There was occasional plastic surgery. In 1895 diphtheria antitoxin was discovered. Operations for quiescent hernia were rare.

Instruments were not disinfected; there were no artery forceps. Absorbable catgut ligatures were introduced by Lister in 1869. There were no modern retractors, and hypodermic syringes and the aspirator were not in general use until toward the end of the Civil War. Gauze sponges came into general use in the late 70's or early 80's, prior to which only marine sponges were used both in clean and in suppurating cases. In dislocations of the hip and sometimes of the shoulder the "barbarous block and pulley" were used. Fractures of the base of the skull were almost uniformly fatal. "Mastoid disease" was unknown by Gross and Erichsen in 1859. Cerebral localization was foreshadowed by Hughlings Jackson in 1867. Localization and subsequent removal of a tumor of the spinal cord were first described by Gowers and Horsley in 1888. Chevalier Jackson was not born till 1865. In the chest, the heart lies in a straight line only one inch from the surface yet as Frederic Lee has strikingly said, it took surgery with laggard step twenty-four centuries to travel that one inch. "Imagine if you can," said Keen, "the forlorn condition of the doctor sixty years ago—without everything except his eyes, his ears, and his fingers; then you can appreciate the triumphal march of medicine during a single lifetime."

Dr. J. Chalmers DaCosta, Keen's successor as professor of surgery in Jefferson in 1907, said of him: "Dr. Keen was always calmer, quieter, kinder, pleasanter, the worse the surgical situation was, and I never saw it get the best of him."

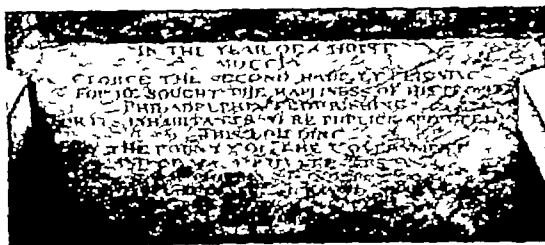
Dr. Keen was a great teacher. He once said: "I always feel at the Jefferson Hospital as if I were on the run with a pack of lively dogs at my heels. Students are the best whip and spur I know." He was a great man, a great American, a great surgeon, and the beloved dean of our medical profession. He knew the joy of living. The "wondrous love of God for Man and the final lofty destiny of the Human Race" was to him "the most impressive, the most inspiring thought of all the ages." In speaking to a group of graduates, he said: "If in your own life you realize the characteristics of the ideal physician—if you attain to old age when the hairs whiten and the crow's feet begin to show when your natural forces are abated, you will then not be alone in the world but will have honor, love, obedience, troops of friends, and one Friend above all others, the Great Physician. We know this was and is his reward. The world is a better place for his having been here. His monument is built in the hearts of his thousands of friends and his memory will live on through the ages." FRANKLIN H. MARTIN

By December 17, 1756, all the patients had been removed from the old quarters into the new building, the wards of which have been occupied continuously ever since.

The records of the patients admitted to the hospital have been carefully preserved and some of the earlier ones are most interesting. Among them we find patients admitted who had been injured by hostile Indians. Thus "March 21, 1756, admitted David Howell, a poor patient from Berks County, having a Gunshot wound and fractured Bone in one Arm done the 6th inst. by the Enemy Indians", and "October 3, Margaret Sinclair, a poor patient, with Disness in the Head having been much abused by the Indians". On October 13, 1755, "Michael Higgins, a Soldier, was admitted, having his underjaw shot off in the late Engagement under General Braddock," and there are entries of many other admissions of soldiers injured during the continuance of the war with the French and Indians.

During the Revolution the hospital underwent some serious vicissitudes. At the outset it was utilized by the Americans but during the British occupation of Philadelphia from September, 1777, to May, 1778, it was taken over by their medical department. When the Americans regained the city the medical department of the Continental Army rented the "Elaboratory" of the hospital for the purpose of preparing medical supplies, and made arrangements for the admission of a number of soldiers on a paying basis to its wards.

On December 31, 1790, Mrs. Stephen Girard, the wife of the rich banker and philanthropist, was admitted as a lunatic pay patient. On March 3, 1791, she gave birth to a daughter, who was put out to nurse by the Hospital Managers, with one John Hatcher's wife. The child died on August 26, 1791, and the funeral expenses were paid by the steward of the hospital. Mrs. Girard died on September 13, 1815. She was buried on the hospital grounds but the exact location of her grave has never been found. Although there are several other entries in the Minutes showing that occasional accouchements occurred in the wards of the hospital, a lying-in department was not opened for many years. In 1793 a legislative act was passed authorizing the hospital to establish such a department, but no further action was taken until 1803, when the Managers formally announced the opening of a lying-in department in the hospital. In 1807 the First Troop of Philadelphia City Cavalry gave the hospital the pay which it had just received from the United States Government for its services during the Revolution, the money to be applied



Inscription on cornerstone of buildings for hospital, laid May 28, 1755

to "the purpose of a Lying-In and Foundling Hospital." No special medical officer was assigned to the department until 1810, when Dr. Thomas Chalkley James was appointed physician to the lying-in department. Drs. Hugh L. Hodge and Charles D. Meigs were both physicians to this department in the forties and fifties during the height of their controversy with Oliver Wendell Holmes on the subject of puerperal fever. The record of the various changes in the location of the lying-in ward is a sufficient index of the contagiousness of puerperal fever. It was opened on the second floor of the East Wing in 1803. In 1817 it was moved to the apartment known as the Contributors' Room, from which it was changed to the second story of the Centre Building in 1824. In 1830 the physicians directed attention to a renewed prevalence of puerperal fever and the lying-in department was ordered closed. Some months later after thorough cleansing and disinfection it was re-opened, but in 1839 it was necessary to move it once more, this time to the Picture House, a small isolated building on the hospital grounds. Here it remained until 1851 when the staff decided that puerperal fever had become endemic, and the ward should be closed. The department was finally abandoned altogether in 1854. A few years ago the Philadelphia Lying-In Hospital was merged in the Pennsylvania Hospital, so that the institution has now a splendidly equipped modern obstetric hospital.

It is noteworthy that the three members of the first medical staff of the Pennsylvania Hospital, the two Drs. Bond and Lloyd Zachary, had all finished off their medical education by study abroad. All of them were men of the highest professional standing and their successors maintained the reputation of the staff and kept the work of the hospital on the highest plane. A brief enumeration of some of those elected to the staff will suffice to show the truth of this assertion. To John Morgan and William Shippen, Jr.,

EARLY AMERICAN HOSPITALS

THE PENNSYLVANIA HOSPITAL OF PHILADELPHIA

FRANCIS R. PACKARD M.D. PHILADELPHIA, PENNSYLVANIA

THE Pennsylvania Hospital was chartered by the Provincial Assembly of Pennsylvania in 1751 and claims to be the oldest hospital established as such in the British Colonies in North America. There are several institutions which are now great hospitals, notably the Philadelphia General Hospital (1731) and Bellevue Hospital in New York (1735) which date their founding prior to that of the Pennsylvania, but they were established as poorhouses or almshouses and shelters for the aged and dependent, and only became hospitals in the modern sense of the term many years later.

The story of the founding of the Pennsylvania Hospital is concisely related by Benjamin Franklin in his *Autobiography*. He ascribes the credit of originating the idea to Dr. Thomas Bond, a distinguished physician of Philadelphia. Bond had endeavored to raise funds by private subscription for the purpose. He had not approached Franklin because he thought it out of his line. However as all those to whom he spoke asked him what Franklin thought about it, he finally determined to consult him. Franklin at once gave him his hearty co-operation, and his political and personal influence to get a charter and raise money, and Bond's project was soon realized. The administration was placed in the hands of a Board of Managers, twelve in number elected from among the contributors. Joshua Crosby, a wealthy merchant, was elected the first president and Benjamin Franklin, clerk of the Board. When Crosby died in 1755 Franklin succeeded to his office.

The hospital was opened for patients in February 1753 in a house rented from the estate of Judge Kinsey on the south side of High (now Market) Street below Seventh. It is curious to find the Managers adopting measures to provide occupation for such patients as could be employed, the modern "occupational therapy" at an early date providing large and small spinning wheels, two pairs of cards, and wool and flax "to employ such patients as may be capable of using the same." The first medical staff was composed

of Drs. Thomas and Phineas Bond, and Lloyd Zachary, with "Drs. Graeme, Cadwalader Moore, and Redman to assist in consultation on extraordinary cases." Benjamin Franklin and Thomas Bond devised a seal for the hospital. It bore a device of the Good Samaritan relieving a sick man, with the inscription "Take care of him, and I will repay thee." The seal was made by a silver smith in Boston and remained in use until 1833, when being worn out, it was broken and a new one bearing the same design and inscription substituted for it.

The hospital soon outgrew its temporary quarters and the Managers purchased a permanent site on which to build on Pine Street between Eighth and Ninth streets. Some years later (1767) the Penn family donated to them a strip of land along Spruce Street, which thus provided the hospital with the entire block, which it occupies to the present day. The cornerstone of the buildings for the hospital was laid on May 28, 1755, with Masonic ceremonies. It is exposed in the wall and bears the following inscription, composed by Benjamin Franklin

IN THE YEAR OF CHRIST

MDCCLV

GEORGE THE SECOND HAPPILY REIGNING

(FOR HE BOUGHT THE HAPPINESS OF HIS PEOPLE)

PHILADELPHIA FLOURISHING

(FOR ITS INHABITANTS WERE PUBLIC SPIRITED)

THIS BUILDING

BY THE BOUNTY OF THE GOVERNMENT

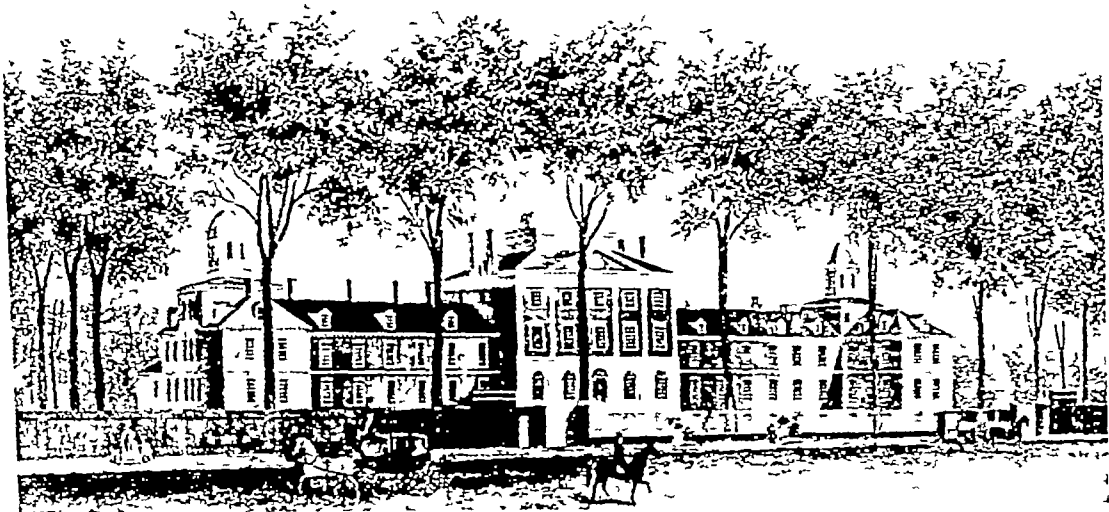
AND OF MANY PRIVATE PERSONS

WAS PIQUALLY FOUNDED

FOR THE RELIEF OF THE SICK AND MISERABLE

MAY THE GOD OF MERCIES

BLESS THE UNDERTAKING.



Pine Street front of the hospital engraved by Tucker, 1820

the hospital with a set of anatomical and obstetrical casts and pictures. The latter had been painted by Van Rymsdyk, the celebrated Dutch anatomical artist, living in London, who had made most of the illustrations for William Hunter's great book on *The Gravid Uterus*. They cost Dr Fothergill 200 guineas. He sent them over to the hospital in the care of Dr William Shippen, Jr, who was returning to America after the completion of his medical studies abroad, and had discussed with Dr Fothergill during his sojourn in London his plans for giving courses in anatomy and midwifery in Philadelphia, and Fothergill wrote the Managers that he hoped his gift would be of use to Shippen or other teachers as he realized that there would be difficulty in procuring bodies for dissection. Shippen had been a pupil of William Hunter in London—the first teacher of anatomy in London to adopt what was known as the "French method" of teaching anatomy, namely providing human corpses for his students actually to dissect, instead of relying on the use of models, casts, and pictures. Although Shippen certainly used the Fothergill casts and pictures we know that he managed to procure bodies for his students to dissect, as he wrote in a published statement that he had received from the judges the bodies of executed criminals, and had also procured some from the Potter's Field.

In 1762, Dr John Fothergill again showed his interest in the hospital by presenting it with a book entitled *An Experimental History of the Materia Medica*, by William Lewis, F R S, "for the Benefit of the Young Students in Physic who may attend under the direction of the Physicians." In 1763 the physicians to the Hospital furthered this idea by presenting the following resolution to the Managers:

"As the Custom of most of the Hospitals in Great Britain has given such gratuities from those students who attend the Wards of the Hospital to the Physicians and Surgeons attending them, we think it properly belongs to us to appropriate the Money arising from thence. And we propose to apply it to the founding of a Medical Library in the Hospital which we judge will tend greatly to the Advantage of the Pupils and the honor of the Institution." This proposal was accepted by the Managers who agreed to provide suitable accommodations for the books, and thus began the first public medical library in this country. Shortly after the library received a number of valuable books from the estates of Dr Benjamin Morris and Dr Lloyd Zachary. William Strahan, the London publisher, in 1774, made a donation of books to the value of one hundred pounds. In 1790 the Managers requested Dr John Coakley Lettsom, of London, to



House of Employment, Almshouse, and Pennsylvania Hospital. (From engraving by Hallett.)

belong the honor of holding the first two chairs in the first medical school founded in the British Colonies, that of the University of Pennsylvania, founded in 1765. Adam Kuhn, the third professor to occupy a chair in the medical school was also physician to the hospital for many years. Benjamin Rush, a signer of the Declaration of Independence, a pioneer in the proper treatment of mental diseases, and the best known medical teacher of his day was constant in his attention to his duties at the hospital from his election to the staff in 1783 until his death in 1813. Caspar Wistar the author of the first American anatomical textbook, and in whose memory the famous Wistar Parties are yet given by members of the American Philosophical Society was a member of the staff for seventeen years. Philip Syng Physick, the most famous surgeon of his day in America, served on the staff from 1794 until 1816. All of these men had received the degree of M.D. from the University of Edinburgh and they all exerted a powerful influence on medical teaching and practice in their day. Of their successors I might recall the names of John C. Otto who wrote the first report of the occurrence of the hæmophilic diathesis in a family John Rhea Barton, the inventor of the Barton bandage and of the "brain dressing" for fractures Hugh L. Hodge and Charles D. Neils, the two eminent obstetricians whose memory is unfortunately forever linked with their erroneous views on puerperal fever George B. Wood, the first editor in collaboration with Franklin Bache, of the *United States Dispensary* and William Wood Gerhard, who established the essential difference between typhus and typhoid fevers.

In 1766 the year after the establishment of the medical school Thomas Bond began giving

courses of clinical lectures in the hospital, the first given in this country.

In 1773 the hospital began taking "apprentices." They served 5 years and at the end of that time if their services had been satisfactory they were given a certificate and a suit of clothes. These young men lived in the hospital and their duties corresponded closely with those of the present day internes, although they were not graduates in medicine. In 1814 the Managers began the practice of taking young medical graduates as resident physicians. The first two, appointed in that year were Caspar Wistar and Caspar Morris.

It is impossible to find out just where operations were performed in the early years of the hospital as there is no mention of any special operating room in the records until 1804, when a clinical amphitheatre was constructed on the third floor of the Centre Building. This room, though the lower part is now used for other purposes, still contains the upper tiers of benches from which students must have witnessed operations by Physick, and heard the lectures of Benjamin Rush and the other great men of the past. In 1809 a new amphitheatre was constructed and the old one abandoned. The second amphitheatre in turn was replaced by a handsome modern operating theatre in 1896.

From its foundation to the present day the Pennsylvania Hospital has extended the use of its wards for teaching purposes. The staff was authorized by the Managers to bring their apprentices or students into the wards, and other students could obtain admission to the operations and clinics at the hospital by the payment of certain fees. In 1762 Dr. John Forbergill, the famous Quaker physician of London presented

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ECLAMPSIA

ITS PREVENTION AND CONTROL BY MEANS OF FLUID LIMITATION AND DEHYDRATION¹

J O ARNOLD, M.D., F.A.C.S., PHILADELPHIA
Professor of Obstetrics Temple University School of Medicine

AND

TEMPLE FAY, M.D., F.A.C.S., PHILADELPHIA
Professor of Neurosurgery Temple University School of Medicine

ECLAMPSIA has required some rational basis of treatment directed toward certain fundamental physiological disturbances that occur within the brain. As the cerebral symptoms, which culminate in convulsive seizures, constitute the serious and terminal manifestations of this condition, an analysis of the problem from this angle is important.

Exploration during the terminal stage of eclampsia has shown the brain to be gray-white (anæmic), oedematous and often associated with excessive amounts of extra arachnoid and subarachnoid cerebrospinal fluid. Histological study indicates widespread cerebral oedema, enlarged perivascular fluid spaces, and frequently punctate hæmorrhages as well as occasional focal or extensive recent subarachnoid hæmorrhage.

Pathologically, the eclamptic brain differs little from "wet brains" or cerebral oedema found in other well recognized hydration states such as acute alcoholic wet brain, status lymphaticus, acute toxic hydration states in children, and status epilepticus.

The terminal cerebral symptoms are similar throughout this entire group. Headache, vomiting, irritability, and mental torpor occur

early followed by stupor, convulsions, and respiratory failure. These symptoms have constantly arisen in neurosurgical problems dealing with brain tumors, increased intracranial pressure, and cerebral oedema. Physiological research during the past 12 years has established many of the factors concerned with intracranial pressure, cerebrospinal fluid circulation and disturbances, which give rise to cerebral oedema. The method of treatment devised to control these symptoms is applicable to eclampsia.

PHYSIOLOGICAL CONSIDERATIONS

Weed and his co-workers (1919-1929) demonstrated that hypotonic fluid (water) given by vein or bowel increased intracranial pressure, whereas hypertonic solutions (magnesium sulphate, sodium sulphate, etc.) decreased intracranial pressure. Rowntree (1922-1926) demonstrated that when quantities of tap water (one-tenth of body weight) were introduced by stomach tube into the dog, irritability, salivation, twitchings, convulsions, stupor, and respiratory failure usually occurred within 4 to 5 hours. If pituitrin was given early in the administration of the fluid so as to produce a vasospastic effect and thus cut down renal elimination, the cerebral symptoms and con-

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select and purchase medical books for the library. Dr. Lettison not only expended most judiciously the money sent him for this purpose, but also donated many books to the library. For many years the library continued to grow and was much used but in the later years of the Nineteenth Century the rapid growth of the Library of the College of Physicians soon surpassed it. In 1893 it contained 14,812 volumes, including a number of medical incunabula, many valuable herbals, and classic medical works, and complete sets of most of the older medical journals, such as the *Lancet* and the *American Journal of the Medical Sciences*.

From its foundation provision was made in the hospital for the care of insane patients. In 1841 a separate department was created for this branch of its work, located on a large tract of land purchased by the Managers for this purpose, in West Philadelphia. From the opening of this department until his death in 1883, Dr. Thomas S. Kirkbride was its physician in chief and superintendent. In the minds of the public this long association led to the bestowal of his name as a synonym for that of the hospital and to many persons "Kirkbride's" was more generally known than the Department for the Insane of the Pennsylvania Hospital.

Francis H Ramsbotham (1861) stated that "the most usual proximate cause of puerperal convulsions, is probably pressure on the brain, and is produced sometimes by serous exudation into the ventricles or between the membranes. Believing that the cause most commonly consists in the pressure to which the cerebral mass is thus subjected, the treatment must be adopted that would be resorted to under ordinary apoplexy, viz the abstraction of blood, and acting briskly on the intestinal canal"

Hugh L Hodge (1864) writes "Puerperal convulsions arise, it has been almost universally believed, from congestion of the blood vessels of the brain, or from actual effusions of serum or blood into its substance or cavities"

Modern theorists consider such convulsions to be the result of a toxicæmia, or blood poisoning, but the evidence of any poison or malcondition of the blood, is exceedingly meagre. Toxicæmia appears to have been inferred, rather than positively proven. I have long been of the opinion that the increased excitability of the nervous system generated by pregnancy (which is very analogous to that of the young child—easily excited to convulsions from comparatively trivial causes), together with the natural tendency to plethora and increased vascular excitement seen in all cases of pregnancy, constitute the predisposing causes of puerperal eclampsia. Such nervous irritation and vascular congestion not only interfere with the functions of the brain, but these changes are often followed by watery or bloody effusion, augmenting to a still greater degree, such functional disturbances.

Should the brain, therefore, be the seat of irritation from a moral cause, followed by congestion, and especially sanguineous effusions, the cerebral functions will be correspondingly deranged as manifested by headache, delirium, convulsions, coma, and it may be death."

Angus MacDonald (1878) states "The most striking alterations, and those I think which we are entitled to regard as the most essential to eclampsia, are (1) the extreme anæmia of the collective cerebrospinal centers, and (2) the coincident equally extreme meningeal engorgement. These two conditions seem to

me to be complementary—the one the result of the other. For explanation of how they arise, we may turn to the theory of Traube as applied to puerperal convulsions by Rosenstein (*Die Pathologie und Therapie der Nierenkrankheiten*, 1870) 'According to this view, eclamptic convulsions are not occasioned by poisons in the blood, but result from cerebral anæmia, which in turn is a consequence of cerebral oedema. The blood of pregnant women is normally increased in quantity, but is of defective quality,—being, in fact, too watery. It is, moreover, propelled under increased tension inasmuch as the left ventricle of the heart hypertrophies during pregnancy—especially in the later months. During labor, this exalted tension is very greatly increased. This results in cerebral hyperæmia, which leads to effusion of serum from the watery blood into the cerebral tissues. The pressure of this oedema reacts so as to prevent the dilatation of the cerebral vessels traversing the oedematous areas, and anæmia is the result.' If this occurs in the cerebrum, we have coma, if in the motor centers, convulsions result."

W Zangemeister (1911) expressed the belief (1) that cerebral oedema, and (2) that reflex painful irritations, particularly those due to uterine contractions, are intimately associated in the cause of eclampsia. Upon trephining the brain in 3 cases of eclampsia during the acute convulsive state, marked cerebral oedema was noted, associated with increased amounts of subarachnoid fluid. In 2 cases marked benefit was shown from this open drainage of the subarachnoid space and the results compare favorably with the work of Alexander (1911) who devised a method of trephining with "fenestration" for treatment of chronic convulsive seizures.

Eight years ago one of us (Fay) observed similar findings in the terminal state of eclamptic convulsions in 2 cases, with marked improvement in the convulsive seizures following drainage. The increase in volume of subarachnoid fluid was striking. The cortex was gray-white, soggy, and oedematous. No other gross lesion appeared in the motor area. Pathological studies in one case disclosed widespread cerebral oedema. The operative and pathological findings were similar to those

vulsions were precipitated much more rapidly. Fremont-Smith (1927-1929) has offered further confirmation of this factor. Noble (1926-1928) showed that dogs given the Rowntree method of "water intoxication," if subjected to continuous spinal drainage during the water introduction period, did not develop convulsions or signs of cerebral irritation. Elsberg and Pike (1926-1929) demonstrated that by hydrated animals were more susceptible to convulsant drugs than the normal and that dehydrated animals required twice the dose of abasynth to produce convulsive seizures required by the normal animals. McQuarrie (1927-1929) has reported the clinical results in human beings where convulsions have been easily induced in the epileptic by the addition of pituitrin in the presence of free indulgence of fluids. One of us (Fay 1923-1930) has shown that excessive fluid intake predisposes the epileptic to an attack and that acute major seizures have been controlled by methods of dehydration.

The recent suggestion of Foster Kennedy (1923-1924) to consider all conditions manifesting convulsive seizures under a single group "The Convulsive State," has found much support from many neurologists. The search for a common factor responsible for the predisposition of the patient to a convulsive seizure has narrowed down to the fundamental relationships between fluid (edema), oxygen, and the acid base variations with their local effect on capillary circulation and permeability. Lennox and Cobb (1928) summarize the following physiological changes in the brain which may tend to precipitate convulsive seizures: (1) poor oxygen supply (2) alkalosis (induced by alkali ingestion or by hyperventilation ("blowing off" carbon dioxide) (3) edema (4) increased permeability of tissues (5) increased intracranial pressure.

It will be seen that these factors all effect fluid mobility and hence enhance an already existing hydration state.

The considerations named indicate that the eclamptic in many respects simulates the prepared physiological animal in that a hydration state usually exists, a vasospastic hypertension is present and there is frequently a renal decompensation associated with fluid reten-

tion. In the past, continued fluid administration to the patient without proper consideration as to its possible elimination has been a constant method of practice in spite of the evident water imbalance. Where skin and bowels are adequate to meet the renal deficiency in fluid elimination a proper balance of fluids is maintained. However with the advent of some sudden curtailment in skin function (cold weather—hyperthermia with dry skin) in the presence of renal insufficiency there may be a precipitation of fluid retention. It is interesting in this connection to note the high incidence of eclampsia in the seasonal change of the early winter months, as well as the frequency of peripheral edema and the occurrence of hydramnios in the light of these recent physiological considerations regarding water metabolism.

Important work regarding the influence of carbohydrates and especially fixed base sodium on the water retention of the body has been done by Gamble, Rose and Tisdall (1923) and the direct relationship between water storage and the convulsive seizure by Gamble (1929) clearly indicates the need for consideration of the problem from this standpoint. Diet becomes of equal importance in the management of water balance in conditions where hydration states tend to occur. Foods high in water content and concentrated carbohydrates (ice cream, candy, syrups, sweet desserts, etc.) must be avoided to prevent water storage during re-establishment of body water balance.

HISTORICAL CORRELATION

George B. Payne (1848) reported autopsy findings in a case of intrapartum convulsions from which he concluded that "it is extremely probable that the serous and cellular structures within the encephalon were also subject to this passive dropy; the effusion, however, was not sufficient in amount to give indications of cerebral pressure until congestion of the cerebral vessels under the parturient efforts, increased the latent pressure so much as to excite the convulsive action. The vessels thus in a state of previous plethora, would readily pour out more of the watery part of the blood causing greater pressure upon the brain.

tion in bed, which is occasionally interrupted by the onset of labor pains in intrapartum eclampsia, the disappearance of convulsive contractions of the hands, an increase in the amount of urine passed, perspiration, a decrease in the tension of the pulse, and then the regaining of consciousness." Though he does not indicate the factors concerned in diet and fluid administration, it is evident that the narcosis induced, temporarily curtails this factor and only in the giving of an enema is there indication that the treatment permits unnecessary administration of fluids. His pronouncement that the convulsive seizure itself is associated with the most evident danger encountered in eclampsia comes undoubtedly from his recognition of the well known fact that intracranial pressure is greatly increased during the active phase of a convulsive seizure. This, if added to an already oedematous structure within the closed confines of the skull, may bring about the terminal compression and failure of the vasomotor and respiratory centers.

Because morphine is a depressant to the respiratory center, its use in large doses has been considered dangerous by us if intracranial pressure already exists. For this reason, it has not been employed except when absolutely necessary in our series. Its use has not been required when adequate dehydration has relieved the pre-disposition to convulsive seizures by removal of the excessive cerebral oedema.

The work of Kocher (1893-1898) and Ito (1899) as well as the recent physiological school of research in water metabolism has offered adequate support to Zangemeister's belief, and in our opinion, confirmation has arisen not only from the observations on epilepsy and the acute convulsive state, but the treatment to be described has been directed toward the prolonged relief of intracranial pressure with results which DeLee has already anticipated.

Plass (1923) has repeatedly called attention to the fact that oedema of the brain is an almost invariable finding at autopsies on eclamptic patients. Moreover, oedema of the lungs was one of the most dreaded complications. It would seem then that water retention is, as Zangemeister insists, an essential

factor in the production of the symptom complex.

Williams (1930, p. 668) lays stress upon the Zangemeister, Traube-Rosenstein theory of cerebral oedema "The headache and eye signs from swelling of the brain and retina," or, as he expressed it in 1921, "the long sought for cause is undoubtedly water." Williams, however, raises two objections first, "that it does not explain the production of the characteristic hepatic lesions," and second, "that it takes no account of the cases of eclampsia without oedema which, in my experience, offer the most serious prognosis."

Concerning the hepatic lesions, there is no direct evidence that they of themselves can produce the cerebral manifestations noted in eclampsia which are common to other convulsive states not associated with hepatic disease. As a contributory factor, they may play a part, but as the pathology is neither pathognomonic or persistently constant in eclampsia as recently shown by the careful analysis of 38 autopsies reported by Acosta-Sison (1931), who states that "it seems to point out that the liver lesions and other acute organic lesions and the convulsions in eclampsia are primarily the result of a common origin."

There are many metabolic and mechanical factors associated with pregnancy and the uterine bulk to produce local changes in intrathoracic and portal venous pressure coincident with the convulsive seizures which might account for some of the acute hepatic pathology.

That cerebral oedema is frequently present in many neurological and neurosurgical conditions without evidence of peripheral oedema permits Williams's second objection to be open to further investigation as undoubtedly the work of Swift (1928-1929) and one of us (Fay) has demonstrated that cerebral venous anomalies and intrinsic disturbances of cortical circulation occur in approximately 16 per cent of "idiopathic" epileptics and some early hydrocephalics.

The predisposition toward cerebral oedema when conditions of renal insufficiency and hydration supervene in this group might be expected readily to predispose certain pregnant patients to acute cerebral disturbances resulting from venous and cerebrospinal fluid

noted in cases of status epilepticus, essential hypertension associated with convulsions, acute uremia of nephritic origin, and alcoholic and post-traumatic wet brains complicated by Jacksonian convulsive seizures. The cerebral edema was common to all and the terminal symptoms similar to those of eclampsia. These observations formed the early basis for the present dehydration treatment and water balance routine employed in the acute and chronic convulsive state and reported elsewhere (Fay 1927-1930).

Hirst (1918 p. 591) places great importance upon renal elimination "as the kidney symptoms increase in severity eclampsia becomes more imminent with improvement in the kidney symptoms, the danger of eclampsia decreases."

From the clinical point of view it is a mistake to minimize the importance of the kidneys and a treatment to avoid strain on the kidneys and to permit free urinary excretion is the only effective treatment of eclampsia except the termination of pregnancy. The kidneys in pregnancy may become insufficient excretors by reason of the kidney of pregnancy or nephritis, of increased intra-abdominal pressure, or of direct pressure on the ureters. It is important in practice to appreciate that the kidneys may be diseased and yet functionally sufficient or that they may be healthy anatomically but functionally insufficient."

DeLee (1928, p. 386) discusses Zangemeister's defense of the theory that increased intra-cranial pressure causes the convulsions and all the symptoms, there being an edema of the brain similar to that occurring in other portions of the body—the legs, the eye-lids, etc. adding — "a very plausible theory and one that if proved, would give us rational methods of treatment."

Stroganoff (1930) stresses the importance of vascular spasm in the origin of eclampsia and there is no doubt that a vasospastic condition obtains (*vide infra*) as the basis for the hypertension and thus, associated with cerebral edema, is sufficient to produce a profound brain anemia, whereas generalized cerebral vascular spasm alone could not account for the clinical findings and would be frequently associated with permanent paralysis as evidenced

in conditions of true vascular spasm encountered in neurological practice. That the state of the vessels determines their permeability to fluids as a factor in this problem has much physiological support. That Stroganoff emphasizes the importance of fluid elimination through the skin is evidenced by his statement that "perspiration which is doubtless connected with weakening or cessation of the vascular spasm, is one of the valuable indications of the favorable course of the disease—fits, as a rule, are then interrupted."

His treatment is directed entirely toward prevention of the convulsive seizure by massive sedative administration and in this respect, he is far in advance of the profession and has reached the point of view held by profound students of convulsive seizures in epilepsy such as Hughlings-Jackson, Gowen, and S. A. Kinnler Wilson. Stroganoff's efforts to protect the motor centers from centrifugal sensory impulses is characterized by isolation of the patient, curtailment of all possible noises, complete removal of all painful stimuli such as hypodermic medication, catheterization and enemata, advocating chloroform anesthesia during their procedures. The liberal use of morphine and chloral hydrate further reduces the central reception of peripheral sensory stimuli. He has thus recognized that the convulsive seizure requires the introduction of a sensory stimulus and that the convulsion *per se* belongs in the category of mass reflex activity and is inherently a neurological mechanism. The most advanced theories today dealing with the problem of the convulsive state stress the point of view that the motor mechanism must be prepared physiologically so that an appropriate sensory stimulus permits its sudden and intermittent discharge.

Physiologically the work of Rowntree, Kubie, Elsberg and Pike, and others, indicates that hydration states most frequently produce the predisposing factor necessary for a true generalized convulsion.

Stroganoff further states "The entire skill in treating eclampsia consists in succeeding in creating such conditions as will interrupt the fits and at the same time lessen the vascular spasm. The symptoms indicating a sufficient effect are as follows: quiet sleep, restful posi-

tion in bed, which is occasionally interrupted by the onset of labor pains in intrapartum eclampsia, the disappearance of convulsive contractions of the hands, an increase in the amount of urine passed, perspiration, a decrease in the tension of the pulse, and then the regaining of consciousness." Though he does not indicate the factors concerned in diet and fluid administration, it is evident that the narcosis induced, temporarily curtails this factor and only in the giving of an enema is there indication that the treatment permits unnecessary administration of fluids. His pronouncement that the convulsive seizure itself is associated with the most evident danger encountered in eclampsia comes undoubtedly from his recognition of the well known fact that intracranial pressure is greatly increased during the active phase of a convulsive seizure. This, if added to an already edematous structure within the closed confines of the skull, may bring about the terminal compression and failure of the vasomotor and respiratory centers.

Because morphine is a depressant to the respiratory center, its use in large doses has been considered dangerous by us if intracranial pressure already exists. For this reason, it has not been employed except when absolutely necessary in our series. Its use has not been required when adequate dehydration has relieved the pre-disposition to convulsive seizures by removal of the excessive cerebral edema.

The work of Kocher (1893-1898) and Ito (1899) as well as the recent physiological school of research in water metabolism has offered adequate support to Zangemeister's belief, and in our opinion, confirmation has arisen not only from the observations on epilepsy and the acute convulsive state, but the treatment to be described has been directed toward the prolonged relief of intracranial pressure with results which DeLee has already anticipated.

Plass (1923) has repeatedly called attention to the fact that edema of the brain is an almost invariable finding at autopsies on eclamptic patients. Moreover, edema of the lungs was one of the most dreaded complications. It would seem then that water retention is, as Zangemeister insists, an essential

factor in the production of the symptom complex.

Williams (1930, p. 668) lays stress upon the Zangemeister, Traube-Rosenstein theory of cerebral edema. "The headache and eye signs from swelling of the brain and retina," or, as he expressed it in 1921, "the long sought for cause is undoubtedly water." Williams, however, raises two objections: first, "that it does not explain the production of the characteristic hepatic lesions," and second, "that it takes no account of the cases of eclampsia without edema which, in my experience, offer the most serious prognosis."

Concerning the hepatic lesions, there is no direct evidence that they of themselves can produce the cerebral manifestations noted in eclampsia which are common to other convulsive states not associated with hepatic disease. As a contributory factor, they may play a part, but as the pathology is neither pathognomonic or persistently constant in eclampsia as recently shown by the careful analysis of 38 autopsies reported by Acosta-Sison (1931), who states that "it seems to point out that the liver lesions and other acute organic lesions and the convulsions in eclampsia are primarily the result of a common origin."

There are many metabolic and mechanical factors associated with pregnancy and the uterine bulk to produce local changes in intrathoracic and portal venous pressure coincident with the convulsive seizures which might account for some of the acute hepatic pathology.

That cerebral edema is frequently present in many neurological and neurosurgical conditions without evidence of peripheral edema permits Williams's second objection to be open to further investigation as undoubtedly the work of Swift (1928-1929) and one of us (Fay) has demonstrated that cerebral venous anomalies and intrinsic disturbances of cortical circulation occur in approximately 16 per cent of "idiopathic" epileptics and some early hydrocephalics.

The predisposition toward cerebral edema when conditions of renal insufficiency and hydration supervene in this group might be expected readily to predispose certain pregnant patients to acute cerebral disturbances resulting from venous and cerebrospinal fluid

circulatory decompensation. These cases would offer a serious prognosis because of the intrinsic cerebral circulatory defect, and the anomalies are sufficiently frequent in the "idiopathic" epileptic group to infer their presence to varying degrees throughout such a common state as pregnancy.

CLASSIFICATION AND TREATMENT

The application of a routine method of treatment directed toward control of the cerebral edema in the acute eclamptic as well as a definite program of management of the fluid balance in the pre-eclamptic was undertaken therefore, in our cases, with the object of controlling or preventing the cerebral manifestations, thus permitting the use of other clinical means to be directed toward the renal insufficiency and hypertension.

We have chosen to divide our patients into three groups, citing illustrative cases in each group: (1) the moderately pre-eclamptic (2) the dangerously threatening pre-eclamptic (3) without chronic nephritis, and (b) with complicating chronic nephritis (3) the actively eclamptic, or convulsant group.

An outline of the treatment recommended for each group based on the physiological considerations noted above, with the results obtained in typical cases, follows.

1. The Moderately Pre-Eclamptic

Patients with definite signs of hypertension, albuminuria, edema of the extremities, headache, and beginning visual disturbances have been placed in this group. In several of the patients all of these symptoms were present, while in others there was only a sufficient number of them to arouse apprehension regarding the further progress of the pregnancy.

The steps used in treatment follow:

a. The total output of urine for 24 hours is measured and charted. (Patient is placed on a minimum of intake or denied fluids entirely during this 24 hour period.)

b. Total fluid intake (water, tea, milk, coffee, soup, fruit juices, and other beverages) is regulated so as not to exceed the amount of urine output for the first 24 hours.

c. As far as practical the level of fluid intake is maintained so as to equal and balance

with the previous day's output. An accurate chart record is made of the intake and output of fluid and the patient is weighed daily.

d. Moderate dehydration is accomplished with small daily doses of magnesium sulphate (saturated solution). The liquid volume of this dose is not to be included in the daily intake chart as this fluid is lost through other than renal elimination.

e. A diet of solid foods of wide varieties including proteins is given. The patient is fed well but moderately, a salt-low diet, soft and liquid nourishment high in water content being avoided as are also sweets and desserts.

f. Food and drink are given at 3 hour intervals throughout the day no eating or drinking being permitted between these small meals.

This routine procedure places the level of intake of fluids at the point of maximum renal efficiency and permits sufficient fluids in the food content to care for skin, breath, and bowel elimination. The mild purgation assists in withdrawing tissue bound fluid from the interstitial spaces, not only in the extremities, but within the cerebral structures as well.

CASE REPORTS

CASE 1. Mrs. S. H., white, aged 32 years, 5 feet, was admitted to Temple University Hospital March 9, 1931 and discharged March 15, 1931. She complained of headache and swelling of the face and feet. Nausea and vomiting had been present during first 3 months of pregnancy but there had been no other symptoms until a few days before she entered the hospital. Examination disclosed swelling of face and ankles. Blood pressure was 185-108. Urinalysis showed specific gravity 1.021 reaction, neutral, cloud of albumin, otherwise negative. Blood urea was 11.5, uric acid, 5.0, creatinin, 1.28, sugar 0.0. Wassermann reaction was negative. Patient gave a history of excessive fluid ingestion and hearty eating. The uterus was midway between the umbilicus and ensiform.

No fluids were permitted during the first 24 hours; the output was 36 ounces. The fluid intake was restricted to 30 ounces. On the second day the output was 25 ounces. The blood pressure fell to 160-94. Patient was much improved. On the third day the intake was 30 ounces and output 47 ounces. The blood pressure fell to 157-84. The edema of face and ankles disappeared. Patient balanced on a intake of 25 ounces. She was discharged on sixth day symptom free with blood pressure of 130-84 and was referred back to her family physician.

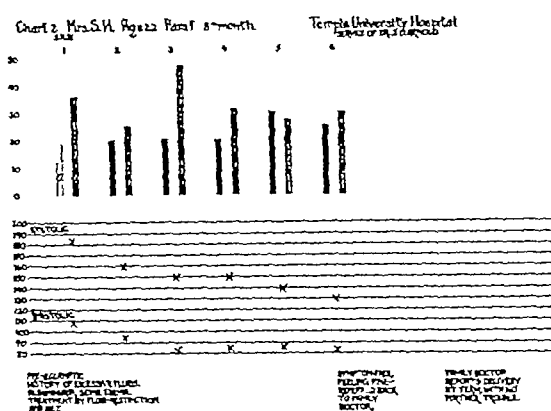


Fig 1 Case 1 Black, intake, gray, output.

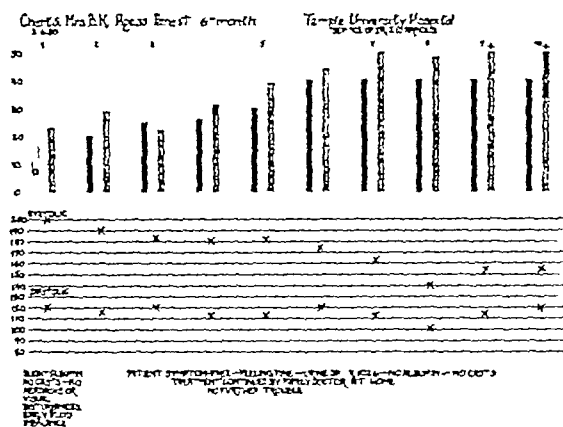


Fig 2 Case 2 Black, intake, gray, output.

Patient came to full term delivery without complications on March 24, 1931. The blood pressure was 164-100, the urine showed cloud of albumin, no casts. Subsequent progress was uneventful.

Note in Figure 1 the excessive output of urine during the 4 days with subsequent clearing of the edema, the prompt fall in blood pressure following dehydration, and the satisfactory progress on 25 ounces of total fluid intake maintained up to the time of delivery.

CASE 2 Mrs. B. K., white, aged 35 years, vi-para, was admitted to Temple University Hospital March 16, 1930, and discharged March 27, 1930. Patient referred because of hypertension (200-120), no other symptoms. Patient had had three miscarriages, two normal deliveries, and was now 6 months pregnant. Hypertension was discovered during the routine examination. No other symptoms were noted. Physical examination was negative. Urinalysis on admission showed specific gravity, 1.020, reaction, alkaline, cloud of albumin, no casts. Blood analysis showed non-protein nitrogen, 75.0, uric acid, 3.3, creatinin, 1.31, sugar 76.9. The Wassermann reaction was negative.

Progress was uneventful with fall of blood pressure to 140-100 on the eighth day. The fluid intake was begun at 20 ounces level and gradually increased to 40 ounces per 24 hours. Patient was discharged on tenth day with blood pressure 156-120, specific gravity of the urine 1.026, with faint trace of albumin. Her condition was good. She was delivered at full term without complications.

It should be noted that patient received no fluids during the first 24 hours. Because of the low output (24 ounces), the intake was placed at 20 ounce level (Fig 2) and was gradually increased as the output rose, the intake being maintained always slightly below the output. The final level of 40 ounces' intake is considered the maximum to meet all body needs, as shown by our experience. It should also be noted that the output was in excess of 50 ounces on the ninth and tenth days, thus indicating the re-

lease of stored tissue fluids and the effect of dehydration. The progressive and sustained fall in systolic pressure indicates the removal of the element of danger in these cases and has been an almost constant finding throughout the series. The vasospastic factor underlying the hypertension remains, as evidenced by the continued high diastolic figure (156-120) on discharge. Under fluid limitation it is interesting to note too the improvement in albuminuria.

CASE 3 Mrs. M. J., white, aged 25 years, 1-para, was admitted to Temple University Hospital February 19, 1931, and discharged March 11, 1931. Her chief complaints were headache, blurred vision, dizziness, swelling of extremities, and dyspnea. She had been well until 4 months prior to admission when, following an automobile accident, she noted pains simulating labor pains. Three months before admission she complained of blurred vision, diplopia, dizziness, and dyspnea at night. Recently she had noticed swelling of the legs, headache, and flushing of the face. There had been an increase in the symptoms of visual disturbance, edema of the extremities, and dizziness. She had had no previous pregnancies or miscarriages. She had had no vomiting spells but had occasional frequency and nocturia. Her diet and fluid intake had been unrestricted. Physical examination disclosed a well developed female, the uterus at ensiform, the extremities edematous, the heart muscle tone good, with accentuated aortic second sound, the blood pressure 158-110, the chest negative. Urinalysis specific gravity 1.007, reaction, acid, heavy cloud albumin, hyaline casts.

With the establishment of a balance of fluid intake and output (Fig 3), the headache was relieved and vision cleared. She had normal labor and delivery February 26, 1931. Recovery was uneventful.

The rapid clearing in the symptoms of edema, headache, visual disturbance, and dyspnea was striking. The balance of intake and output indicates the mild saline purgation was adequate in removal of the excess tissue fluids so long as fluids were restricted to the level of output. The blood pressure

circulatory decompensation. These cases would offer a *serious prognosis* because of the intrinsic cerebral circulatory defect, and the anomalies are sufficiently frequent in the 'idiopathic' epileptic group to infer their presence to varying degrees throughout such a common state as pregnancy.

CLASSIFICATION AND TREATMENT

The application of a routine method of treatment directed toward control of the cerebral edema in the acute eclamptic as well as a definite program of management of the fluid balance in the pre-eclamptic was undertaken therefore, in our cases, with the object of controlling or preventing the cerebral manifestations, thus permitting the use of other clinical means to be directed toward the renal insufficiency and hypertension.

We have chosen to divide our patients into three groups, citing illustrative cases in each group: (1) the moderately pre-eclamptic; (2) the dangerously threatening pre-eclamptic (a) without chronic nephritis, and (b) with complicating chronic nephritis; (3) the actively eclamptic, or convulsant group.

An outline of the treatment recommended for each group based on the physiological considerations noted above, with the results obtained in typical cases, follows.

1. The Moderately Pre Eclamptic

Patients with definite signs of hypertension albuminuria, edema of the extremities, head ache, and beginning visual disturbances have been placed in this group. In several of the patients all of these symptoms were present, while in others there was only a sufficient number of them to arouse apprehension regarding the further progress of the pregnancy.

The steps used in treatment follow:

a. The total output of urine for 24 hours is measured and charted. (Patient is placed on a minimum of intake or denied fluids entirely during this 24 hour period.)

b. Total fluid intake (water, tea, milk, coffee, soup, fruit juices, and other beverages) is regulated so as not to exceed the amount of urine output for the first 24 hours.

c. As far as practical, the level of fluid intake is maintained so as to equal and balance

with the previous day's output. An accurate chart record is made of the intake and output of fluid and the patient is weighed daily.

d. Moderate dehydration is accomplished with small daily doses of magnesium sulphate (saturated solution). The liquid volume of this dose is not to be included in the daily intake chart as this fluid is lost through other than renal elimination.

e. A diet of solid foods of wide varieties including proteins is given. The patient is fed well but *moderately* a salt-low diet, salt and liquid nourishment high in water content being avoided as are also sweets and desserts.

f. Food and drink are given at 3 hour intervals throughout the day no eating or drinking being permitted between these small meals.

This routine procedure places the level of intake of fluids at the point of maximum renal efficiency and permits sufficient fluids in the food content to care for skin breath, and bowel elimination. The mild purgation assists in withdrawing tissue bound fluid from the interstitial spaces, not only in the extremities, but within the cerebral structures as well.

CASE REPORTS

CASE 1. Mrs. S. H., white, aged 22 years, 1-para, was admitted to Temple University Hospital March 9, 1931, and discharged March 13, 1931. She complained of headache and swelling of the face and feet. Nausea and vomiting had been present during first 3 months of pregnancy but there had been no other symptoms until a few days before she entered the hospital. Examination disclosed swelling of face and ankles. Blood pressure was 184-108. Urinalysis showed specific gravity 1.031 reaction, neutral, cloud of albumin, otherwise negative. Blood urea was 11.5, uric acid, 5.0, creatinin, 1.18, sugar 0.0. Wassermann reaction was negative. Patient gave a history of excessive fluid ingestion and hearty eating. The uterus was midway between the umbilicus and xiphoid.

No fluids were permitted during the first 24 hours the output was 36 ounces. The fluid intake was restricted to 20 ounces. On the second day the output was 25 ounces. The blood pressure fell to 160-94. Patient was much improved. On the third day the intake was 20 ounces and output 47 ounces. The blood pressure fell to 138-84. The edema of face and ankles disappeared. Patient balanced on 22 intake of 45 ounces. She was discharged on sixth day symptoms free with blood pressure of 130-84, and was referred back to her family physician.

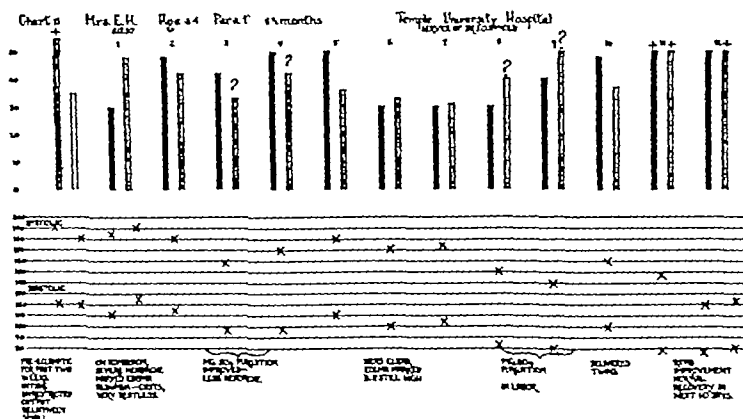


Fig 5 Case 5 Black, intake, gray, output, striping, measured fluids immediately before admission.

Group A, without Chronic Nephritis

CASE 4 Mrs B Q, white, aged 34 years, i-para, was admitted to Temple University Hospital March 20, 1930, and discharged March 25, 1930. She complained of severe headache, dizziness, slight visual disturbances, and marked oedema of face, and lower extremities. Patient had good general health, having had no illnesses since childhood. She had been slightly nauseated in first 3 months of pregnancy, but had had no other symptoms or disturbances until 2 weeks before admission. Headache was the first symptom. Hypertension was noted a week later. The oedema was noted in last 2 weeks. Headaches had increased. The history indicated an effort to increase the output of urine, by forcing fluid intake and giving cathartics. Both patient and her physician were much alarmed at the rapidly increasing severity of symptoms. Patient was a well developed woman, with heart and lungs normal. The fundus of the uterus was two fingers below the ensiform. The fetal heart was heard in the lower right quadrant. There was marked oedema of the ankles and legs. Blood pressure was 200-120. Urinalysis showed specific gravity, 1.014, reaction, acid, trace of albumin, no casts. Blood analysis showed non-protein nitrogen, 27.5, uric acid, 3.6, creatinin, 1.27, sugar, 76.3.

All fluids were withheld for 24 hours (Fig 4). The fluid balance was maintained at about 50 ounces, with daily doses of 1 ounce of saturated solution of magnesium sulphate by mouth, followed by rapid improvement. Patient was returned to the care of her family physician after 5 days. The headache was entirely relieved. Blood pressure was 134-90. With a continuation of fluid balance treatment at home, there was no return of her pre-eclamptic symptoms. Normal delivery at term.

This patient developed her pre-eclampsia rather suddenly, and her danger symptoms advanced rapidly. With fixation of the fluid intake level and general routine in diet following the necessary de-

hydration measures, a normal state ensued followed by an uncomplicated delivery.

CASE 5 Mrs E H, white aged 34 years, 1-para, was admitted to Temple University Hospital March 15, 1930, and discharged March 29, 1930. She complained of headache, dizziness, blurred vision, oedema of legs, restlessness, and insomnia. She had had influenza in 1918, but no other serious illness and no operations. She had had some nausea and vomiting in the second month of pregnancy. Until about 3 weeks before admission, she had had no other disturbances during pregnancy. Swelling of the legs became alarming about 3 weeks ago. Visual disturbances occurred about 2 weeks before admission. A noticeable diminution in the output of urine had occurred recently, and there had been an attempt to overcome this by increasing the fluid intake. Headache began about 10 days ago with daily increasing severity. She did not vomit. Eating had been irregular and erratic. She suffered marked fear and restlessness. Patient was fairly well nourished, well developed. The teeth were in poor condition, many were missing. The heart showed fair muscle tone, no murmurs. The lungs were normal. The abdomen had the size and appearance of an unusually large, full term pregnancy. The fetal heart was heard in the right lower quadrant. There was marked oedema of the legs and feet. Blood pressure was 176-100. Urinalysis showed specific gravity, 1.020, reaction, acid, heavy cloud of albumin, hyaline and granular casts. Blood analysis showed sugar, 80, non-protein nitrogen, 35.7, uric acid, 4.6, creatinin, 1.26. The Wassermann reaction negative.

The urine output for the first 24 hours was 34 ounces. Patient was given an allowance of 30 ounces in the second 24 hours. There was marked improvement following the restriction of fluid intake and repeated magnesium sulphate purgings. Marked improvement seemed to warrant continuation of the pregnancy. Normal convalescence and spontaneous full term delivery ensued.

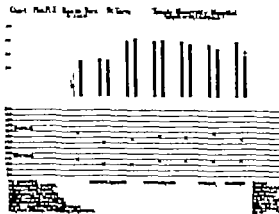


Fig. 3. Case 3. Black, inlet; gray, outlet.

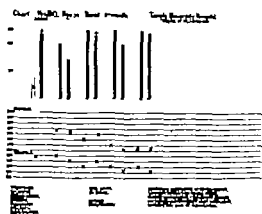


Fig. 4. Case 4. Black, inlet; gray, outlet.

on discharge was 120-95. The urine showed no casts and a trace of albumin.

In the moderately pre-eclamptic group a prompt and beneficial effect was noted when the patients were placed on restricted fluid intake not in excess of the predetermined output. Headache, visual disturbances, edema, and the hypertension disappeared. The vaso-spastic underlying condition remains in some cases as evidenced by the persistence in high diastolic pressure. The urinary picture improves definitely under proper fluid balance and mild purgation. A normal full term delivery occurred in all patients of this group.

2. The Dangerously Threatening Pre Eclamptic

In this group are those (a) without chronic nephritis, and (b) with complicating chronic nephritis.

This subdivided group includes those patients having a marked or alarming degree of hypertension, albumin and casts and external edema with aggravated headache, vomiting, visual disturbances, or other cerebral symptoms. It is difficult or often impossible to classify pre-eclampsia patients accurately on the basis of the presence or absence of pre-existing nephritis; yet, the history, clinical findings, and laboratory and eye ground studies, usually make such a division practicable.

The general principles of treatment are the same for group A and B but group B requires earlier application of the treatment with

more careful and persistent control of fluids and diet as the response is slower and the danger of renal suppression more imminent.

a. All fluids (and usually all food) are withheld until the 24 hours urine output is known; then an intake at or slightly below the daily output is maintained.

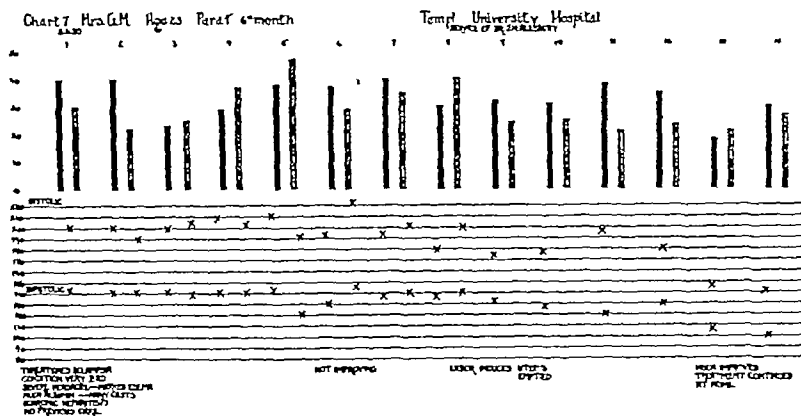
b. The process of dehydration is begun at once by giving intravenously 50 cubic centimeters of 50 per cent glucose and this dose is repeated in 4 to 6 hours, if necessary.

c. A saturated solution of magnesium sulphate, one or more doses, is given by mouth until effective in watery stools. This is repeated daily or as indicated.

d. If no marked improvement is seen in 15 to 30 hours, one or more spinal drainages is done, at 4 to 6 hour intervals, or rarely when spinal puncture is impractical, venesection is done, the blood pressure cuff being used as a tourniquet in order to check the effect on pulse pressure.

e. A strict balance of fluid and "dry" solid diet is maintained.

This more intensive method of dehydration permits adjusting treatment to the degree of urgency apparent in the case. Many patients in this group yield promptly and satisfactorily to one or more of the measures without spinal drainage, if fluid intake is carefully curtailed but spinal drainage should not be long deferred if headache and other cerebral symptoms have not decidedly abated within a few hours.



not had medical attention, or any occasion for urinalysis or blood pressure test before pregnancy. She began to notice swelling of ankles and increased severity of headache about 2 months ago. There were no visual disturbances. Nausea and vomiting began 5 months ago and have continued in varying severity since. Patient's general physical condition appeared fairly good. Her teeth were in poor condition and there was marked gingivitis present. The tonsils were enlarged and injected. The thyroid was not enlarged. The heart and lungs appeared normal. The abdomen showed an enlarged uterus with uterine fundus at the level of the umbilicus, otherwise the abdomen was normal. The fetal heart sounds could not be heard. Both legs were markedly swollen, and there was some oedema of the face. Blood pressure was 204-144. Urinalysis showed specific gravity, 1.012, reaction, acid, heavy cloud of albumin, no sugar, many hyaline and fine and coarsely granular casts. The Wassermann test was negative. Blood sugar was 66.6, non-protein nitrogen, 20, uric acid, 2.9, creatinin, 1.49, hæmoglobin, 74, red blood cells, 3,350,000, white blood cells, 10,800, polymorphonuclears, 68, small lymphocytes, 23, large lymphocytes, 6, mononuclears, 0, many crenated red cells.

Some improvement followed the restriction of fluids, but the pulse pressure remained high. On third day, glucose and magnesium sulphate were given intravenously, and headache and other symptoms were much improved following this medication. Hypertension persisted, but patient continued to improve and felt well. At this time, and for several days before, patient felt no fetal movements, and signs of fetal life were not found on examination. On the ninth day in the hospital, labor was induced because of dead fetus, and uterus expelled macerated fetus on tenth day. Continued restriction of intake and mild dehydration by magnesium sulphate purgings gave steady improvement, and patient was discharged after 24 days in hospital to be under care at home. The urine still showed albumin and casts. Final blood pressure was 140-100.

From the fact that this patient had a dead fetus at the sixth month, with no discoverable cause except nephritis, and from the subsequent slow recovery after leaving the hospital, with urinary evidences of nephritis that have persisted, it seems fair to assume that this was a case of early pre-eclampsia in which chronic nephritis was a predisposing and aggravating factor. Her immediate, urgent, cerebral symptoms responded to the routine treatment. Emptying the uterus of a dead fetus was but a necessary adjunct to the regular treatment. Here, as in 2 other cases in our series (Case 6, group a, and Case 8, group b), there is an apparent refutation of the widely prevalent idea that the death, or removal of the child, lowers blood pressure, and lessens the danger of eclampsia. It is important to note (Fig 7) that blood pressure showed a definite fall from 210-144 to 190-120 on the fifth day following dehydration, and this was coincident with a rise in the urinary output on that day. On the sixth day there is evidence of water storage with a subsequent rise in blood pressure. The blood pressure had fallen to 174-132 even before the uterus was emptied on the tenth day. There followed a period of water storage with a rise in systolic pressure even after the induced abortion and not until the thirteenth day when fluid intake was sharply cut to 16 total ounces did the blood pressure fall to its final proper relationship.

CASE 8 Mrs M K., white, aged 37 years, iv-para, was admitted to the Greatheart Maternity Hospital of Temple University, service of Dr C S Barnes, March 29, 1931, and discharged April 18, 1931 She complained of severe headache, dyspnoea, extensive oedema, difficult locomotion, and disturbances of vision She is now in the ninth month of pregnancy She has felt bad throughout pregnancy She has had three previous, full term, uneventful pregnancies, the last 9 years ago Three children are living and well Patient has greatly increased in weight since the birth of the last child She has had no miscarriages and no serious illness in recent years She has been nauseated and has vomited for past 7

Case 6. March 23, April 22, 1931

Temple University Hospital

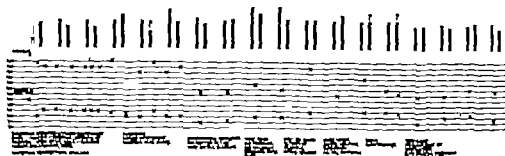


Fig. 6. Case 6. Black, intake; gray output.

In the 24 hours immediately preceding admission to the hospital, this patient upon instruction had measured her fluid intake which was more than 76 ounces, as indicated by the first column in Figure 5. The urine output had not been previously measured, but the history indicated that for some days or weeks, her intake had greatly exceeded her output.

The rapid and continued improvement following the correction of her fluid imbalance indicates the serious importance of this factor alone in the management of such a case.

CASE 6. Mrs. L. J., white, aged 32 years, 1-para, was admitted to Temple University Hospital April 4, 1931 and discharged April 22, 1931. She complained of constant severe headache, some blurring of vision, frequent attacks of hiccough, lasting half hour to an hour at a time and absence of signs of fetal life. Patient had had pneumonia when 3 years old, and scarlet fever at the age of 14 years. She has had no illness since, and there had been no occasion to have blood pressure taken or urinalysis made, until about a month before admission to the hospital. The first 4 months of her pregnancy had passed in normal health, and without complaint. One month ago, she was moderately shocked by a fall while walking. Two days later she began to feel badly and went to a physician. She was told that she had high blood pressure. Patient became greatly worried and nervous. Repeated examinations by her physician in the next 3 weeks failed to discover signs of fetal life, but showed increasing hypertension. She had an attack of vomiting week ago. Headache and hiccoughs had been worse during past week. Physical examination revealed the following: patient, well developed; heart sounds, normal; lungs, clear; uterine fundus, half way to umbilicus; no noticeable edema; no heart sounds or fetal movements discovered. Blood pressure was 180-170. Urinalysis showed specific gravity 1.013; reaction, acid; heavy cloud of albumin; no casts; no sugar; no red blood cells.

A strict fluid balance maintained at 20 ounces with daily magnesium sulphate purgings brought

prompt relief of headache, but hypertension and hiccough persisted. On the sixth day spontaneous abortion of a macerated fetus of about 4 months size occurred. The hiccough ceased. Continued improvement was noted. Patient asked for more fluid. For 2 days the allowance was increased by 10 ounces above the daily output of urine. This increase was followed at once by a rise in blood pressure to 180-140 and a return of headache. The fluid balance was therefore re-established, and the patient became symptom free and continued to improve until her discharge.

A case of missed abortion, probably from accidental cause, at the end of the fourth month, and persisting a month, developed dangerously threatening pre-eclamptic symptoms, but improved rapidly on dehydration without the aid of drug therapy and in the presence of an unusually low fluid balance. When the fluid intake was increased even to ounces above the daily output of urine, there was a prompt return of the danger symptoms within 48 hours in spite of the fact that the uterus was empty and the patient was free from any infection or pelvic abnormality. The immediate relief obtained upon returning to the previously determined fluid balance of 20 ounces, clearly indicated the value of fluid restriction. No other means of dehydration were found necessary except occasional magnesium sulphate purgation.

Group B with Complicating Chronic Nephritis

CASE 7. Mrs. G. M., white, aged 23 years, 1-para, was admitted to Temple University Hospital, service of Dr. J. M. Alebury March 26, 1930, and discharged April 9, 1930. She complained of headache (frontal and occipital) attacks of vomiting, swelling of feet and legs, restlessness, and insomnia. Patient was 6 months pregnant. She had had no serious illness since childhood. She had had measles at age of 8 years. She had been subject to attacks of headache once or twice a week for several years. Headaches had become worse since pregnancy. She had

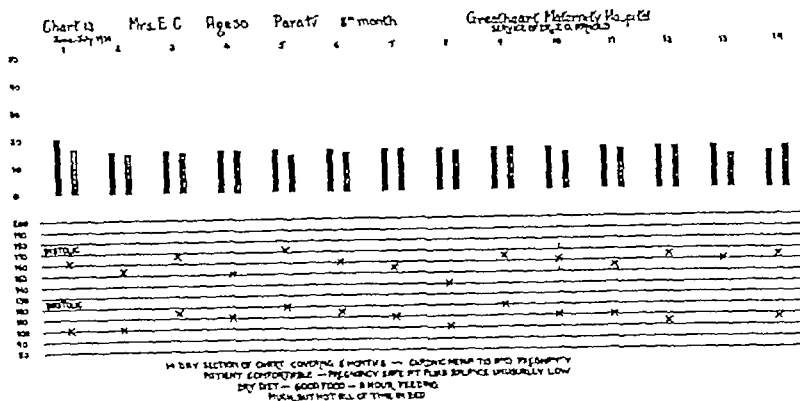


Fig 9 Case 9 Black, intake, gray, output.

The heart action was strong, regular, and no murmurs were heard. The lungs were normal. The abdomen was thin-walled, and the uterus was small with fundus midway between umbilicus and ensiform. There was slight pretibial and ankle edema. Blood pressure was 153-109. Urinalysis revealed the specific gravity to be 1.025, reaction, acid, cloud of albumin, sugar, negative, hyaline and granular casts.

Patient remained cheerful and comfortable when kept quiet in bed, on good food with strict fluid balance treatment. Her appreciation of the obvious relationship between her sense of well-being and the unusually low fluid allowance (an average of 15 ounces) made absolute co-operation possible, and she expressed no desire for further increase. This fluid level was maintained throughout the ensuing 5 months (including June and July) until a normal, spontaneous labor, not far from full term, resulted in a well developed, living child weighing 4½ pounds, and left the mother in good physical and mental condition.

Under conditions far from being the most favorable, a patient with chronic nephritis which has once endangered, and twice prematurely disrupted her pregnancy, was carried safely through a fourth pregnancy to normal parturition, at or near term, with an apparently healthy child, by careful fluid balance methods. That so low a fluid intake could be maintained over so long a period of time, without great hardship to the patient, and certainly without detriment to her health, is important, and confirmatory of similar experiences with renal complications in other conditions.

Summary The 6 patients in this group all gave undoubted evidence of threatened eclampsia and responded promptly and beneficially to the effects of systematic restriction of fluid intake and the milder methods of dehydration. Their cerebral symptoms were promptly controlled, and their hypertension

and renal functions were more or less favorably influenced. Four of the 6 gave birth to living babies at term. In 1 of Group A the pregnancy was accidentally interrupted at the fourth month, and in 1 of Group B there was intra-uterine death of the child (possibly from the mother's nephritis) at the sixth month. All made normal puerperal recoveries and those with chronic nephritis, have convalesced in a manner to warrant the assumption that their kidney lesions were not greatly aggravated by the pregnancy thus properly controlled and conducted.

In 3 of our cases, in which each former pregnancy was complicated by eclampsia, or pre-eclampsia, requiring the termination of pregnancy because of the association of chronic nephritis, full term normal babies have been delivered, without the advent of eclamptic symptoms, when the patients were placed upon a total intake of fluid not exceeding 20 ounces, throughout the period of pregnancy.

3 The Actively Eclamptic, or Convulsant Group

We have placed under this division, only those patients in whom such an advanced stage of eclampsism had been reached that convulsive seizures had actually begun. We are not unmindful of eclamptic death without convulsions, but for clinical purposes, the more or less arbitrary grouping into three stages of severity herein outlined, has seemed best to meet the needs for a practical guide in administering treatment.

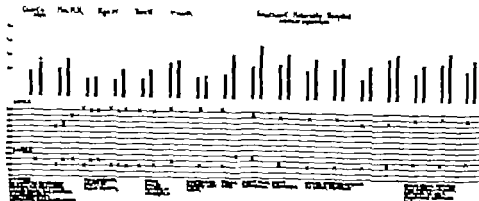


Fig. 2. Case 2. Black, intake; gray output.

months. She began to have headache, edema of legs, and ocular symptoms about 2 months ago, with occasional attacks of nausea and vomiting. There is much distress and pressure in the abdomen. Frequent micturition has been noted day and night, but the urine has been scant in quantity. There has been no restriction of fluid intake or diet. She has had severe attacks of coughing at times. Dyspnea has been marked, and the headache and all symptoms have been aggravated in the past week. For years, she has been a moderate user of alcoholic drinks. Physical examination disclosed a patient of medium height, very stout, excessively fat and edematous. The uterus was at the ensiform. The heart sounds were good, but rapid (90 per minute). The lungs were normal. The fetal heart was heard in the left lower quadrant. Blood pressure was 3.0-110. Urinalysis showed the specific gravity to be 1.034, reaction, acid; very heavy cloud of albumin; no sugar; many hyaline and granular casts.

Blood-letting on admission and 24 hours later (30 ounces in all) and restriction of fluid intake (12 to 26 ounces) to amount of output, brought prompt relief from headache and a pronounced feeling of well-being. The edema, visual disturbances, and all symptoms greatly improved, but hypertension remained unchanged, with little change in urinary findings. Induction of labor with normal easy delivery was accomplished on the seventh day in the hospital, but there was no improvement in blood pressure or change in the progress of case. However patient continued to feel well, improved symptomatically and was discharged on a fluid intake level of 20 to 26 ounces, to continue treatment for her chronic nephritis at home.

The prompt and striking relief of all alarming symptoms, except the hypertension, that followed dehydration methods, was gratifying. As a pre-existing kidney lesion is frequently aggravated when pregnancy is unnecessarily prolonged, it was deemed wise to induce labor early in this case. Characteristic of all cases in this general group of pre-eclampsia superimposed on chronic nephritis, the

lowering of blood pressure and the clearing of urinary findings following the delivery were not immediately seen, and the subsequent reports on this patient, after several months, showed very slow recovery with evidences of chronic nephritis still present. In this type of case the underlying hypertensive factor is one of cardiorespiratory disease complicating pregnancy, but it is important to note that such cases yield satisfactorily to prolonged dehydration measures without clinical evidence of renal aggravation and even improve symptomatically in spite of the former beliefs to the contrary.

CASE 3. Mrs. E. C., white, aged 30 years, iv-para, was admitted to the Greatheart Maternity Hospital of Temple University July 9, 1931, and was discharged August 5, 1931. Patient was admitted from out-patient service because of headache, hypertension, scanty urine, and known record of chronic nephritis. Patient was 8 months pregnant. She had had measles, mumps, and whooping cough as a child. She had been married 12 years. She had had appendectomy and right oophorectomy 4 years ago. She had been in good health prior to the first pregnancy 8 years ago. This pregnancy had been terminated by induction of labor at end of the eighth month because of high blood pressure and kidney disease. The child weighed but 3 pounds, but is living and healthy. Patient did not consult a physician again, until second pregnancy 3 years ago, which ended in spontaneous abortion (said to have been due to kidney disease) in the sixth month. A third pregnancy 1 year later ended in miscarriage at the sixth month. Patient applied at the out-patient service in the fourth month of the present pregnancy complaining of headache, dizziness, transient visual disturbances, and beginning edema of face and feet. Blood pressure at that time was 165-100. The urine contained albumin and casts. She was treated as an out-patient, except for a period of 10 days in the hospital (June 23 to 25) until present time. Carefully regulated diet and fluid balance methods were instituted. Physical examination reveals a small, frail looking, poorly nourished woman.

CASE 11 Mrs. K. B., white, aged 32 years, multipara, was admitted to the Temple University Hos-

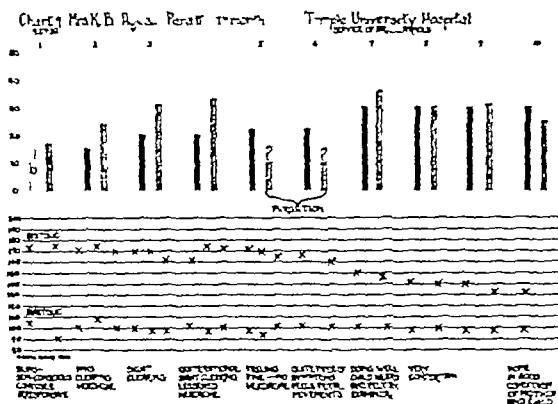


Fig 11 Case 11 Black, intake, gray, output.

She had no convulsions after she was admitted to the hospital. Venesection bringing the blood pressure down to 150-90, with 50 cubic centimeters of 50 per cent glucose followed in 2 hours with 20 cubic centimeters of 10 per cent magnesium sulphate intravenously, and the withholding of all food and liquids for 24 hours, brought about an early clearing of all symptoms. The output of urine for the first 24 hours was only 17 ounces, so her allowance of fluid intake for the next 24 hours was 15 ounces. By the end of a week, a fluid balance of 30 ounces had been established, and this, with mild magnesium

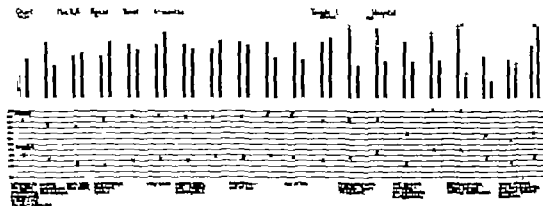


Fig. 10. Case 10. Black, intake; gray output.

a. Hypodermic injection of sodium luminal, 2 or 3 grains is given immediately and repeated in 2 hours if necessary. Morphine sulphate $\frac{1}{4}$ to $\frac{1}{2}$ grains is given hypodermatically only if absolutely necessary and only after the administration of glucose and spinal drainage have been accomplished.

b. At the earliest possible opportunity 50 cubic centimeters of 50 per cent glucose is given intravenously.

c. The spinal fluid is drained as completely as possible (45 to 100 cubic centimeters) preferably with the head raised to an angle of 30 degrees. (When spinal drainage is impracticable, venesection, until systolic pressure drops 30 to 50 points, may be substituted.)

d. The administration of glucose is repeated in 3 to 4 hours, and spinal drainage in 4 to 6 hours, if marked improvement is not seen.

e. Magnesium sulphate is given by mouth or bowel in effectual doses.

f. Absolutely no fluids (except magnesium sulphate solution) are given for at least 24 hours, and the temperature, pulse, respiration, and pulse pressure are recorded every hour.

g. If dehydration has been thorough and effective, the uterus need not be emptied nor labor induced or hurried, except for reasons other than the attack for which the patient is being treated.

The treatment here outlined provides (1) for a primary sedative directed toward the control of the convulsive seizures (2) for the early use of hypertonic solutions to attract

into the blood stream the tissue bound water (3) for immediate and rapid cerebral dehydration (by spinal drainage or venesection) which is an extremely important factor not only in controlling convulsions, but in bringing about early mental restoration, with all its advantages in the further conduct of the case (4) the use of an active saline purge to withdraw the fluid from the blood stream reclaimed by the intravenous glucose and thus hasten a re-establishment of body water balance.

A repetition of the intravenous glucose and of the spinal drainage, with the maintenance of an accurate fluid balance, and a continuance for some days of milder dehydration by purgation, provides for the further restoration of the patient. The strict avoidance of fluid introduction by vein, skin, or bowel (enema—8 ounces of magnesium sulphate and 1 ounce of glycerine) other than prescribed is important. For complications of severe hemorrhage blood transfusion should be done and the 50 per cent glucose administration repeated.

CASE REPORTS

CASE 10. Mrs. R. S., white, aged 34 years, 4 para, was admitted to the Temple University Hospital April 5, 1930 and discharged April 30, 1930. Patient was brought to hospital in convulsions and unconscious. She had been married 10 months and is now 6 months pregnant. She had had typhoid fever when a child, appendectomy at age of 17 years, and tonsillectomy 2 years ago. There had been much nausea and vomiting during second and third months of pregnancy but no serious complaints after this until about a week before admission to the hospital. The convulsive seizures were immediately preceded

The danger of rapid administration of fluid during labor, in cases in which the urinary output is low, is clearly shown in this case. Patient came to labor at full term, without complaint, or suggestion of complication, except a very moderate gradual rise in blood pressure, amounting to about 25 points in 4 months. Under the stress of labor, and the heat of the season, there was noted, but not measured by the nurses, an unusually large intake of water during labor. The tremendous amount of stored body fluid released during the following 7 days is most striking in spite of the fact that no fluid was given on the day following delivery. The precipitation of cerebral symptoms in the presence of such fluid imbalance during the stress of labor has led us to cite this case as evidence that the principles involved in the water balance of the body should receive most careful attention even in cases in which pre-eclamptic signs are not present, and especially so, *during labor*.

Summary The illustrative cases presented in this group, include three degrees of convulsive severity, in three different types of patients, at three separate periods of pregnancy. The first, an unusually severe attack, early in the sixth month, with a recurrence in 2 weeks. The second, a moderately severe type, late in the seventh month, in a patient with a questionable nephritis and a history of a former pregnancy terminated by eclampsia. The third, a sudden severe attack, intrapartum, in a patient undoubtedly organically sound. In all of these, it will be noted, that the prompt control of convulsions, early mental restoration, and rapid clearing of other cerebral symptoms, followed the proper application of the dehydration methods herein outlined.

DEDUCTIONS

The foregoing routine treatment, as might be expected, includes methods long known and accepted. In fact, the success obtained in this series has been primarily due to the establishment and prolongation of the temporary benefits formerly derived from such dehydrating measures as purgation, sweating, and blood letting. Our attempt has been to maintain the prompt clinical improvement of symptoms which follows these various methods of dehydration. In attempting to carry out limitation of fluid and extended modified dehydration, it has been necessary to abandon the almost fanatical belief that large quantities of fluids are necessary to "wash out the toxins," and to recognize that many of the "toxic"

symptoms are produced by the excessive fluids themselves, inducing a clinical state of "water intoxication" similar to that produced by Rowntree, responsible for some of the fundamental factors in the problem of eclampsia.

Irrespective of the underlying vasospastic-renal-hepatic disturbance there is a superadded "water intoxication" resulting in a clinical type of cerebral hydration and a terminal sequence of events characterized by convulsions, stupor, and respiratory failure. With the control of this factor according to physiological methods now at hand, we believe that the therapeutic art is capable of directing proper treatment toward the underlying etiology. Even in patients with well established chronic nephritis, it has been possible to protect the patient against the almost certain eclampsia by careful management, and watchful attention directed toward the cerebral physiology and water balance.

In spite of the traditional belief that large quantities of fluid are necessary in renal deficiency, it has been well established during the past 5 years, not only in the above group, but in many other types of cases encountered, requiring dehydration and complicated by nephritis, that symptomatic improvement follows fluid limitation, and renal signs of irritation have actually improved or remained stationary during long periods of dehydration. In fact, in over 300 cases inclusive of the epileptic, arteriosclerotic, cardiorenal, prostatic uræmic, and acute toxic infectious states maintained on dehydration, there has been no advance in the renal pathology noted or increased disturbance of renal function. Contrary to what has been popularly believed, 8 to 10 ounces of urinary output per day has been found to be sufficient for proper elimination of solids, provided concentration is possible as evidenced by a high specific gravity of the urine. Blood urea nitrogen has not shown an increase in the presence of dehydration as evidenced by the studies of Thomas (1931) on the post-prostatic uræmic.

In the light of these observations, the arguments in favor of placing a pathologically involved renal system in a state of partial physiological rest has been borne out by clinical experience with other organs such as the lungs.

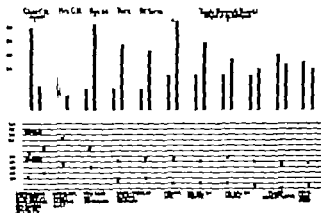


Fig. 3. Case 2. Black, intake gray output striping, undrafted intake.

sulphate purgations, enabled us to discharge her in good mental and physical condition after 10 days' treatment, with pregnancy undisturbed.

It is interesting to note the rapidity of recovery following simple dehydration and continued fluid limitation (compare with Case 10) in the light of her former experiences in pregnancy with the very slow recovery (many convulsions and mental confusion for 10 days) following venesection, sedatives, and the pushing of fluids by skin, bowel, and mouth in the former attack. It is doubly interesting to us, for one of us directed her treatment in each attack. A further vitally important consideration is the fact that the child's life was not sacrificed by our present methods, as it was by the methods of 3 years ago.

As this patient was under the care of one of us (Arnold) during her former pregnancy the opportunity to contrast the methods in use 3 years ago with the present routine for the control of eclampsia was afforded. During her former attack, venesection, purgation, and sedatives were used but as was then customary fluids were pushed by mouth, skin, and bowel. Her recovery was slow and associated with mental confusion and many convulsions. The adoption of a rational fluid balance and the methods of proscript dehydration during the last pregnancy made possible not only a quick recovery from the eclamptic state but the subsequent successful delivery of a living child so much desired but formerly considered impossible of accomplishment.

CASE 12. Mrs. C. H. White, aged 25 years, 1 para was admitted to the Temple University Hospital July 5, 1931 and discharged July 16, 1931. She was having normal, moderately severe labor pains, at 5 to 8 minute intervals (in first stage, spontaneous labor at term). Patient had had no illness since childhood, and no nausea or vomiting or other complaints during pregnancy. She had been regularly under dispensary care since the fifth month. She had had only very slight edema of the ankles

in these 4 months of prenatal care. Blood pressure had also very gradually increased in these four months: February 24, 1931, 130-80; April 15, 1931, 126-80; May 11, 1931, 120-74; May 24, 1931, 120-90; June 15, 1931, 140-90. Urine at no time contained more than a faint trace of albumin and no casts. Patient had been in normal labor for about 18 hours. Diagnosis: breech presentation, well tolerated labor pains. Convulsions had come suddenly without forewarning complaint or symptoms. During the period of labor fluid restriction had been removed and the patient had consumed large quantities of water. She at no time complained of headache, dizziness, or vomiting preceding the convulsions. The specific gravity of the urine was 1.019, reaction, acid; cloud of albumin; no sugar; no casts, no red blood cells. The Wassermann and Kahn tests were negative.

There had been 3 convulsions of the prolonged, severe type. Blood pressure after first convulsion was 55-10. She was given 50 cubic centimeters of a 50 per cent glucose solution intravenously. The second convulsion came 25 minutes after the first. Spinal drainage, as completely as possible, was done immediately after the second seizure. Patient remained unconscious and wildly restless (uterus was in active labor). In 30 minutes, there was a third and much lighter convulsion. Magnesium sulphate, 30 cubic centimeters of a 0 per cent solution, was given intravenously. Patient remained much quieter after the third convulsion and was conscious and rational in less than an hour after the last convulsion. Spinal drainage, followed by spinal anesthesia and breech extraction was done in 2 1/2 hours after convulsions ceased. Child cried at once, was normal, and well developed. Patient was maintained on a greatly restricted fluid intake and mild saline purgation, recovery was rapid, and the condition of the mother and baby was excellent on discharge, 12 days later.

the initial state. Blood letting is of value as an emergency procedure, but robs the patient of millions of red blood cells, so necessary as the carriers of oxygen to the functioning tissues. The cerebral tissues require large amounts of oxygen. In the presence of anæmia and anoxæmia, not only is function of the brain disturbed and reduced, but permeability of capillaries is increased and tissue œdema gradually supervenes. Oxygen must be maintained at all costs and hence the red blood cells preserved, if possible, as well as sufficient and optimal circulation through the capillaries, so that tissue function may be maintained.

As blood volume remains one of the most fixed values in the body, the withdrawal of a pint of blood is followed within a few hours by a re-establishment of the volume in terms of available fluid. Thus, the patient has been but temporarily benefited from the standpoint of fluid volume and reduced arterial pressure, only to re-establish subsequently the same volume at the expense of a loss of important oxygen carriers as well as protective white blood cells, removed at the time of blood letting. If blood letting is repeated, a secondary anæmia ensues with little actual loss in blood volume.

As the problem of hypertension primarily depends upon three factors, it is necessary to consider them individually in order to direct our clinical methods toward their control and readjustment. (1) blood volume remaining ordinarily at a fixed level is contained within (2) tubes (arteries, capillaries, and veins) of adjustable volume, filled and refilled by an organ pump (3), the heart.

With blood volume as a comparatively fixed quantity, it is evident that arterial tension is dependent upon an efficient heart and the size of the arteries and arterioles which produce the resistance and tension.

Contraction in the size of the arteries and arterioles may be due to arteriosclerosis, vasospastic irritants (drugs, toxins, local mechanical factors), or central vasomotor influences. Thus, in the presence of a diminution in the caliber of the arterial tree, there is consequently a definite shift of blood volume to the venous side, favoring passive congestion and

overfilling of the venous bed including the right side of the heart. With the rise in venous pressure, there is a delay in venous return from the brain through the jugulars, and a subsequent delay in elimination of cerebrospinal fluid, favoring initial stages of intracranial pressure and cerebral œdema. With the onset of cerebral œdema and pressure impairment of capillary circulation of the brain, there is a central response to the vasomotor center, giving rise to an increase in general arterial blood pressure as evidenced by the experiments of Forbes and Wolfe (1927-1928). The central vasomotor spasm thus initiated favors a further rise in intracranial pressure due to the superadded general arterial vascular constriction and a vicious cycle is thus induced by the progressive increase in intracranial pressure and general systemic blood pressure (compare with Traube-Rosenstein theory noted above).

The hypertension which has rapidly responded to dehydration in our series, especially on the systolic side, in the majority of cases, can be explained only upon this basis in that the measures directed toward the relief of intracranial pressure and cerebral œdema have reduced the need for a superadded rise in general arterial pressure to overcome the impending cerebral anæmia. In a few cases, little or no response in the blood pressure resulted from these measures and it is probable that the primary factor of hypertension had its origin from the state of the vessels or the presence of some general vasospastic stimulant, rather than intracranial pressure.

Behney (1931) has suggested the possibility of hyperpituitary function during this stage of the pregnancy as being responsible for the vasospastic state, and it is certain that there is much evidence of gross physical changes during the period of pregnancy to favor the view that pituitary hyperfunction with acromegalic tendencies does occur. It is noteworthy in this series that the fundamental underlying vasospastic or toxic condition, whether of pituitary origin or otherwise, has persisted as evidenced by the continued high diastolic pressure that in many cases has not materially responded to dehydration. As

heart, and the general principles involved in pathological processes confined to the extremities.

To force the renal mechanism to its utmost during periods of decompensation seems as unsound in principle as would be the enforcement of violent exercise on a decompensating heart.

Irrespective of the renal factor it is evident that the total amount of fluid ingested must find some avenue for escape to maintain proper physiological relationship throughout the body. The definite avenues of escape are skin, breath, bowels, and kidneys. If renal elimination is demonstrably less than the total intake inclusive of the water contained in ordinary foods, it is evident that skin, breath, and bowels must compensate to maintain the proper balance, or excessive fluid will be retained in the body. The volume of moisture lost through the lungs varies somewhat with the body temperature and respiratory rate, but for clinical purposes remains approximately fixed. The compensatory load is thus placed upon the bowels and skin. If compensation is adequate, no disturbance in water metabolism occurs. The variability of skin function is determined by environmental temperature relations, activity of the patient, and induced physiological states of activity. The character of the bowel movements determines the volume of fluid lost by this route. If diarrhea supervenes, compensation may be possible for excessive amounts of fluid unable to escape through the usual renal and skin portals of elimination. However vomiting often is induced through the central mechanisms to promote fluid elimination. With prolonged and excessive vomiting the acid radicals of the gastric contents are also eliminated from the body giving rise to an alkalemia and this in turn as shown by Lennox and Cobb is a correlary of edema, bringing forth a state of tissue bound fluid which, if contained within the cerebral mass may be followed by symptoms of headache, dullness, stupor and convulsions.

Thus, surrounding the problem of water metabolism lies the need for a careful analysis of the relationship between the intake and output of patients with recognized renal de-

ficiency. From a clinical standpoint, it is possible to measure accurately the fluid intake and to establish a diet relatively fixed in its water content, and thus the known quantities entering the body can be readily established. The measurement of urinary output taken in conjunction with the daily weight will establish the relative storage or elimination of fluids ingested. As 16 ounces weighs approximately one pound, the weight gain or loss is almost entirely in terms of fluid. The amount of solid matter lost even in emaciating diseases approximates less than one-tenth of the total. Thus, if a patient whose intake and output have balanced each day shows signs of gain in weight, it is evident that the fluid derived elsewhere (food, enema, etc.) has been stored within the body tissues, and conversely with an established fluid intake and output balance, loss of weight indicates a loss of stored tissue fluids through other than renal channels (skin and bowels). This fluid is usually from the interstitial reservoirs but also in catabolic processes, intracellular to some extent (see Gamble, Ross, and Tisdall).

Carbohydrates favor water storage in that the cells of the body on carbohydrate metabolism require two-thirds more water than when maintained upon a protein metabolism. Sodium chloride, it is believed also favors fluid retention due to the fixed base sodium. Hence, in maintaining a fluid balance in the body it is important to eliminate excessive carbohydrates from the diet such as sugar, candy, ice cream, honey, syrups, jelly and preserved fruits, thus leaving the economy to obtain its necessary carbohydrate requirements from the vegetables and starches contained in an ordinary diet. A salt low diet is maintained by curtailing the use of salt at the table and avoiding salty foods such as chipped beef, pretzels, salted fish, and highly seasoned soups or foods.

Hypertension. As purgation, sweating, and blood letting are all immediate means of dehydration it is evident that the results obtained by these beneficial clinical measures should be established and prolonged. To permit the refilling of the fluid reservoirs of the body by immediate ingestion of uncontrolled amounts of liquids favors a prompt return of

work of Rowntree and supported by the clinical observations of many practical obstetricians. In our opinion, eclampsia is probably a *syndrome* rather than a "disease" and takes its origin from a variety of disturbances which produce a common cerebral reaction indicating that no specific etiological cause can be expected to be responsible for the various clinical manifestations of this condition. Thus, by separating the eclamptic state into its cerebral and systemic component parts, it has been possible to direct the treatment toward the cerebral manifestations with strikingly beneficial results.

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diastolic pressure primarily represents the state of constriction of the arteriole and the peripheral capillary bed resistance. It is evident that though dehydration may protect the systolic range and maintain it outside of the danger zone, there still remains the underlying factor concerned with the vasoconstrictive state, coincident at this period of pregnancy. For all clinical purposes this factor is rarely dangerous to life and may concern us only in relation to its effect upon oxygen dissociation and its availability to the tissues. As the optimum dissociation of oxygen occurs between the pressures of 60 and 40 millimeters of mercury (MacLeod, 1923) it is important in order to maintain an adequate optimal oxygen supply to the tissues that the diastolic pressure registered in the brachials should be maintained above 60 millimeters mercury and not above 90 millimeters mercury. However many compensatory factors assist in the proper oxygen relationship in the periphery provided the carriers (red blood cells) are not reduced to a profound degree.

Blood letting has, therefore, been practiced in this series only in emergencies and blood volume has been temporarily reduced by active purgation associated with intravenous glucose to assist blood volume in obtaining its replenishment from the interstitial storage reservoirs (cerebrospinal fluid, brain, liver muscles, etc.), repeating purgation so as again to deplete blood volume, requiring it to turn to the tissue reservoirs for its source of readjustment rather than to fluids ingested and thus easily obtained. Hence, the rationale of fluid limitation and even its complete curtailment during the active period of dehydration in the well advanced type of cases.

Magnesium sulphate intravenously has been advocated as a means of producing dehydration and there is no doubt that its action is similar to that of glucose in assisting to withdraw the tissue bound fluids into the blood stream where they may be more easily subjected to elimination. Magnesium sulphate is not eliminated through the kidneys, does produce renal inflammation, and for the most part is excreted into the large bowel. In our opinion several cases of ulcerative colitis may have been precipitated or augmented by the

use of this drug intravenously. Although its use is not definitely contra-indicated, 50 per cent glucose has been found to be as effective and has the advantage of being metabolized within the tissues, thus serving a dual purpose as a hypertonic dehydrating solution, and as a factor to combat acidosis, as well as containing definite nutritional values.

SUMMARY

A series of cases have been presented illustrating a method of fluid balance and dehydration in the pre-eclamptic, dangerously threatening and actively convulsant groups, with and without chronic nephritis as a complicating factor. The results have indicated that the rational, proper balance of fluids has controlled the cerebral symptoms of headache, vomiting, stupor, convulsions, and respiratory disturbances that systolic hypertension has been favorably influenced and that the renal function has definitely improved in the majority of cases.

Because of the absence of any mortality in this series or in the cases coming under our care since inaugurating this treatment, and the marked beneficial and prolonged results obtained during the past 2 years, it is our opinion that further continuation and refinement of this method are warranted. Certain fundamental clinical principles long recognized have been placed in a better physiological relationship and continued maintenance of the former temporary improvements obtained by older clinical methods justify the belief that the condition known as eclampsia is subject to prevention and control along the lines of a properly established water metabolism.

In the analysis of the problem, it is evident that symptoms must be divided into those related to cerebral disturbance secondary to a superimposed hydration state with characteristic responses attributable to "water intoxication," and those symptoms and disturbances which are fundamentally responsible for the initiation of a definite imbalance in water metabolism throughout the body. That a demonstrable toxin is unnecessary for the production of the clinical cerebral signs has been well established by the physiological

PRIMARY CARCINOMA OF THE LUNG

WITH A REPORT OF A CASE TREATED BY OPERATION

C I ALLEN, M D, F A C S, AND F JANNEY SMITH, M D,¹ DETROIT, MICHIGAN

UP to a comparatively recent date the rather extensive literature on primary carcinoma of the lung has concerned itself largely with reports of series of autopsied cases. During the past decade the increased evidence of this disease has resulted in a marked renewal of interest, both on the part of the pathologist and of the clinician. It has also given more ample opportunity for study so that ideas as to cell type and histogenesis have to a certain extent become clarified.

The story of primary lung carcinoma has been admirably presented in Adler's monograph and in papers by Weller, Barron, Brunn, Simpson, Fishberg, Grove and Kramer, Eloesser, Moise, and others, and with a reference to these will, therefore, be presented only briefly here.

As early as 1810, pulmonary carcinoma was described in what Ewing terms a vague manner. It was not until 1871 that Langhans presented the first microscopical studies and expressed the opinion that these tumors arose from bronchial mucous membrane. This gave impetus to a search for them in the pathology laboratories so that by the end of the nineteenth century series of cases were being reported. Additional ones have been added until there are now well over 1,000 reported cases, most of which fulfill the requirements suggested by Weller in 1913, in writing of primary bronchial carcinoma, namely, that (1) an autopsy shall have been performed, (2) the carcinomatous nature of the condition shall have been verified microscopically, and (3) there shall be no reasonable suspicion that the lesion is not a primary one.

In 1912, Adler published his monograph on primary malignancy of the lungs and bronchi in which he reported 374 cases, together with notes on the clinical as well as the pathological phases of the problem. He was keenly aware of the advances that had been made in thoracic surgery and of further advances to be

hoped for, and made the rather startling recommendation that, when a suspicion of tumor existed and all available means of diagnosis failed, exploratory thoracotomy should be done.

In 1913, Weller in a study of primary carcinoma of the bronchi, collected 90 cases, discarding some of those previously reported as lacking of sufficient data. At this date he urged the use of the bronchoscope and X-ray in order to arrive at earlier diagnoses. Curiously enough, almost 10 years later Barron sounded a note of warning against bronchoscopy and exploratory thoracotomy with the statement that both procedures were too difficult to be recommended.

INCIDENCE

The undoubted increase of incidence has been commented upon by many writers. This has been attributed to inhalations of gas fumes or dust particles laden with oil or tar products from the streets, to cigarette smoke, and to the residual inflammatory conditions of influenza. Weller felt that the apparent increase might be due to a clearer realization of the frequency and a resultant more careful search and in a later paper, in which he analyzed all available statistics up to 1927, stated that the sharpest rise in frequency occurred about 1910. Others felt that it appeared about 1918 to 1922.

Increased diagnostic acumen and an increasing interest undoubtedly account for some of the additional cases but are hardly responsible for so great a change in incidence. Definite and accurate information will be obtained only by the compilation of such figures as appear in Simpson's report from the London Hospital. Here is presented an analysis of the hospital statistics which shows in comparison of tumors found to autopsies performed a percentage increase from 0.51 in 1907 to 2.05 in 1925. Likewise, in comparing the primary carcinoma of the lung to total

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bronchial epithelium in the presence of inflammation. Moise pointed out that both the bronchial and alveolar epithelium of patients dying of influenza showed striking and atypical proliferative changes resembling carcinoma. It is not unreasonable to suppose that other irritants might produce similar alteration. Another confusing factor is the finding of various cell types in a single tumor.

ETIOLOGY

As with carcinoma elsewhere in the body, the cause of that in the lung is unknown. A number of etiological factors, however, have been suggested. Ewing states that the chief one of these is tuberculosis and cites the appearance of neoplastic growths in diseased lung tissues. In this Barron concurs to a certain extent in that he believes that the increased incidence is probably due to fore-running inflammatory conditions, the most important of which is tuberculosis. In Adler's series of 374 cases only 19 had evidence of tuberculosis. Of the 282 cases reported by Ferenczy and Matolcsy, 44 showed healed lesions at the apices, calcareous bronchial glands or, occasionally, old cavities. Only one showed evidence of active tuberculosis. In a series of 246 cases, Kikuth found some evidence of tuberculosis in 22 but did not consider it of etiological importance. In Simpson's 139 cases from the London Hospital, 47 showed some evidence of tuberculosis, but in only 6 was it an active pulmonary type. Of the four larger series, then, with a total of 1,041 cases only 132, or 12.6 per cent, showed any evidence of tuberculosis and of these only a small portion had active pulmonary lesions. Grove and Kramer, in reporting 21 cases, found tuberculosis present in only 1, in spite of the fact that the series was presented from a large county hospital where the patients ordinarily ran a fairly high incidence of tuberculosis. From these observations one would conclude that the etiological relationship of the two conditions is not great.

Cherry has expressed an original view of the inter-relationship of these two diseases. He believes that carcinoma attacks in later life those who have overcome tuberculous infection in earlier years and considers that the

TABLE II—COMBINED CLINICAL AND POST-MORTEM STUDY OF LONDON HOSPITAL (AFTER SIMPSON)

Year	Total malignant neoplasms	Carcinoma of lung	Percentage
1907	607	6	1.0
1908	618	13	2.1
1909	753	14	1.9
1910	724	12	1.7
1911	814	15	1.8
1912	708	11	1.6
1913	750	17	2.3
1914	835	13	1.6
1915	878	17	1.9
1916	663	14	2.1
1917	866	9	1.0
1918	666	17	2.6
1919	753	18	2.4
1920	744	20	2.7
1921	682	24	3.5
1922	720	22	3.1
1923	777	31	4.0
1924	744	28	3.8
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acquired resistance to tuberculosis is the predisposing cause of cancer. He also points out that the sum total of deaths from tuberculosis and carcinoma has varied little in the past 30 years and constitutes 20 per cent of the causes of death after the age of 25. While interesting, this opinion is wholly the result of interpretation of statistics and lacks scientific data for its establishment.

It was suggested by Winternitz, Wasson, and McNamara in their study of the pathology of influenza that it might not be unreasonable to expect an increase in pulmonary carcinoma to follow the epidemic. Moise feels that the proliferative changes which occur in the lungs of those dying of influenza, previously alluded to, suggest the possibility of a causal relation between the two conditions. While expressing no definite opinion in this regard, Simpson points out that the sharpest increase of incidence in his series of 139 cases occurred from 1918 to 1922 and feels that this fact in itself might lend some credence to the theory of cause and effect between the two conditions. Others noted the peak of incidence before the influenza epidemic and felt that no relationship existed.

The inhalation of tar products with dust from the streets has been suggested by Staehelin as a possible cause of lung carci-

TABLE I.—LONDON HOSPITAL STATISTICS POST MORTEM STUDY (AFTER SIMPSON)

Year	Autopsies	Carcinoma of lung	Percentage
1907	82	6	0.51
1908	239	0	0.78
1909	288	8	0.63
1910	208	7	0.58
1911	265	5	0.40
1912	905	8	0.83
1913	878	8	0.91
1914	784	5	0.64
1915	719	5	0.69
1916	653	4	0.61
1917	58	3	0.5
1918	65	4	0.65
1919	645	6	0.93
1920	750	8	1.07
1921	598	9	1.50
1922	580	1	0.70
1923	604	1	0.82
1924	578	1	1.73
1925	585	12	2.05

malignant growths found, there was a percentage increase from 1.0 in 1907 to 3.7 in 1925. These figures are so striking that Tables I and II are reproduced.

The statistics from most hospitals where large series have been collected show a similar increase, but in most instances the figures of a great many years are grouped together so that the story is not so vividly portrayed. In this series, as may be seen, the most rapid increase occurred from 1918 to 1922.

PATHOLOGY AND HISTOGENESIS

Theoretically primary lung carcinoma may arise from the lining of the bronchi, the bronchial mucous glands, or the alveolar epithelium. Confusion has arisen because of several misinterpretations. It now seems fairly clear that many of the lung tumors which have been diagnosed as sarcoma were carcinoma of the undifferentiated cell type and that sarcoma of the lung is an extremely rare condition as pointed out by Weller, Klotz, Ewing, and others. Likewise it is now fairly generally accepted that squamous celled carcinomata may have their origin in the bronchi and do not necessarily arise from alveoli.

Ewing clearly describes three types of lung carcinoma, according to histogenesis. First, those arising from the bronchial epithelium. These are composed for the most part of squamous or cylindrical cells. With the

former the structure is usually quite uniform throughout, while with the latter a great variety of histological pictures occurs. Obstruction of bronchi leads to the secondary changes of atelectasis, bronchiectasis, and abscess formation. Necrosis of the tumor mass may also occur as the blood supply becomes inadequate. Second those arising from the bronchial mucous glands. This type is usually found in the wall of the bronchus. The structure tends to be gland like and is composed of small cuboidal or polymorphous cells. In some instances the acinar structure may be obscured by tumor cells producing finger-like processes. Variations from the typical structure are frequent. Third, those arising from the alveoli. These may be either diffuse or multiple and nodular. In this type the air vesicles may be completely filled with masses of cells of cuboidal, cylindrical or squamous form with varying grades of obliteration of the vesical walls, or dilated vesicles may be partly filled with papillary projections composed for the most part of cylindrical cells.

While admitting the theoretical conception of possible origin from the three sources, Simpson points out that the polymorphism of the cells usually makes such a division impossible. In this he is in accord with Weller.

It is concerning the third group that most discussion has arisen. Weller has said that of 14 cases studied in none was there more than presumptive evidence of alveolar origin and that this was on the basis of the presence of chronic fibroid pneumonia at the apparent site of origin. He states that both the most fully and the least differentiated types may be found in close relationship to main bronchi and that all the intermediate forms may be arranged in a logical series. He feels that the type of cells of which the tumor is composed is much more an indication of its differentiation than of its precise histogenesis. Klotz concurs in this feeling and states that in general it is impossible to determine the exact site of origin but that gross and microscopical evidence points strongly to a bronchial origin for most of the tumors.

Part and possibly all of the difficulty of exact determination of histogenesis arises from the occurrence of metaplasia in the

bronchial epithelium in the presence of inflammation. Moise pointed out that both the bronchial and alveolar epithelium of patients dying of influenza showed striking and atypical proliferative changes resembling carcinoma. It is not unreasonable to suppose that other irritants might produce similar alteration. Another confusing factor is the finding of various cell types in a single tumor.

ETIOLOGY

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Fig. X-ray plate taken April 29, 1930, showing the tumor mass in the right base directly above the diaphragm.

noma but proof is lacking. However Simpson points out as suggestive the fact that, in Hong Kong and Singapore where the roads are not tarred carcinoma of the lung is very rare. He feels that the known potentialities of tar as an irritant, together with its wide use in treating roads, present a problem worthy of scientific investigation.

The inhalation of oil chemical fumes, and cigarette smoke has also been mentioned as a possible cause but no proof is available.

The theory of inhalation irritative etiology may be given some credence from the fact that these tumors occur from three to four times as frequently in men as in women.

No discussion of etiology would be complete without mention of the Schneeberg tumors. For many years the mines in the region of Schneeberg in Saxony have been productive of a radioactive ore containing iron, bismuth, tin, zinc, lead, manganese, uranium, cobalt and nickel in combination with sulphur and arsenic. It was long ago recognized that a great many of the mine workers developed lung diseases from which they sooner or later died. As early as 1879, Harting and Hesse reported that 79 per cent of the deaths

occurring among the miners were due to a pulmonary condition which they described for the most part as a lymphosarcoma involving the bronchial glands. They collected data for a period of 9 years from 1869 to 1877. The average number of men employed during this time was 650 and during this period 150 died, usually in an emaciated state bordering on cachexia. In 1913 Arnstein suggested that possibly many of these cases were tuberculosis or pneumoconiosis, and this opinion was apparently partly substantiated by Saupé who concluded that the conditions were in part pneumoconiosis and in part actual lung malignancy. These reports led Barron to state that these tumors were no longer used in arguing in favor of an irritative cause and were now considered as inflammatory conditions. As a matter of fact, a commission has subsequently again studied the condition, and the conclusions arrived at and reported by Schmorl in 1923 and by Schmorl and others, in 1924, substantiate the earlier belief that these tumors are in reality carcinoma. A group of 154 miners was observed over a period of three and a half years. In this time 21 of them died and of these 13 or 62 per cent, were diagnosed at autopsy as having primary carcinoma of the lung. If two who had been out of the mines several years, are excluded, the percentage is 52. During this same period 362 non mine workers were also observed and no evidence of carcinoma was found. Schmorl, therefore, concluded that pulmonary carcinoma was still endemic in this region and that the condition was a true epithelial new growth.

In this instance the possible causes are many. The dust itself may be a factor. Added to this is the chemical effect of the various ingredients of the ore particularly of the arsenic. Perhaps the radioactivity and the fungi which grow in the mines are causative factors.

It would seem not unreasonable to suppose that possibly all of the suggested causes may have some influence, and that as Weller predicts, the condition may be found to be "due to (1) an inheritable intrinsic predisposition which may be activated by (2) a variety of chronic irritative factors. These may be



Fig 2 X-ray plate taken April 29, 1930, in the lateral position. This shows the tumor mass less distinctly in the posterior portion of the thorax.



Fig 3 X-ray plate taken June 24, 1930, following operation showing narrowing of right thorax, clouding of entire right side.

mechanical, chemical, bacterial, thermal, or radioactive, but they have in common the ability to incite proliferation in certain cells, regeneration, repair, hyperplasia and often metaplasia."

SYMPTOMS

The symptoms vary with the location of the tumor and with its size and duration. It is clear, therefore, that a constantly changing clinical picture exists and that no symptom complex can be laid down as pathognomonic. Weller analyzed the records of 100 cases in an effort to clarify the direct relationship of physical signs and symptoms with the pathology found. The symptoms which he enumerates are in the main those noted by others. Cough, pain, sputum, at times blood stained, and dyspnoea are the four most common ones due to the primary local pathology. Less frequently and later appear cyanosis, dysphagia, stertor, and pleural effusion.

Mediastinal involvement, in the order of frequency, produces cough, pain, dyspnoea, cyanosis, venous engorgement, recurrent laryngeal paralysis, hoarseness, inequality of the pupils, inequality of the radial pulse, abdominal pain, dysphagia, and stertor.

General systemic effects, which usually appear only late in the disease, are loss of weight, weakness, osteo-arthritis, fever, chills, cachexia, anorexia, and nausea and vomiting.

The signs and symptoms of metastatic tumors other than those of the mediastinum vary with the part involved, the most pronounced being those referable to the central nervous system.

METASTASES

In this connection it must be borne in mind that the metastatic tumors not infrequently give rise to symptoms in the new location before the original site is suspected of disease. All observers are agreed that metastatic spread occurs widely and in many instances very early. Weller states that tumors composed largely of columnar or of undifferentiated cells metastasize widely and early while the cornifying squamous cell type spreads chiefly by local extension, with late metastases to the regional lymph glands. The non-cornifying squamous cell type acts similarly, although somewhat less restricted than the other variety.

Adler's collected series of 374 and Simpson's series of 139 from the London Hospital show a fair uniformity of distribution of metastases. By far the most frequent are those in the regional lymph glands. Fre-



Fig. 4. X-ray plate taken February 9, 23, showing haziness over entire right side, especially at the base. The hazy shadows are about as appear in earlier films.

quently involved, also are widely scattered portions of the skeletal system, the liver, and the lungs and pleura. Metastases to the brain are not uncommon. Those to other organs or parts of the body are less constant but not infrequent.

COURSE

From a study of many reported cases it is obvious that the duration of illness is extremely variable. In some a rapid downhill course occurs, with death within a few weeks or months of the onset of symptoms. In a few instances it seems fairly clear that the condition existed for as long as 3 or 4 years after the appearance of the initial symptoms. A surprisingly good state of health may exist in the presence of these tumors with loss of weight and cachexia appearing only in the late stages of the disease. The duration of life will depend largely upon the complications which occur and on the extent and location of the metastases.

The obstruction of a bronchus by tumor with resultant atelectasis and bronchiectasis not only changes the clinical and X-ray findings but with the added intrathoracic suppuration the symptoms become more pro-

nounced and the course more rapidly downhill. In fact not a few of these cases have been treated with the thought that the secondary condition was the primary one, the latter being discovered only at autopsy.

DIAGNOSIS

The diagnosis of primary carcinoma of the lung in its early stages is rarely made, largely because of the insidious character of its onset. It is only by constantly bearing in mind such a possibility that early diagnosis may be made. The clinical data are of immeasurable value but with a constantly changing condition no criteria may be laid down. The history is often suggestive, with the dry cough gradually becoming productive of slightly bloody sputum. Pain in the chest, while helpful in directing attention to this area, is not especially characteristic. The roentgenogram is of the greatest aid, especially if the tumor is discreet and well out from the hilus and should be made with the chest in various positions. The use of lipiodol injection into the bronchus will sometimes outline a tumor which is otherwise obscure but is not to be entirely relied upon because of the technical difficulties and because various grades of encroachment upon the lumen of the bronchus may give variable results.

As with any intrathoracic diagnostic problem, suppurative or neoplastic, with the possible exception of uncomplicated empyema, bronchoscopy is frequently of the greatest assistance. While this has not been widely practiced until comparatively recently as early as 1910 Rénon, Géraudel, and Marre reported making a diagnosis of squamous cell carcinoma of the lung from a bit of tissue removed from the left lower bronchus with the bronchoscope. It is largely with the use of this instrument that earlier diagnoses may be made.

Lilienthal has been an advocate of exploratory thoracotomy and biopsy in those instances in which a diagnosis of intrathoracic pathology cannot be otherwise established. This seems a justifiable procedure, for with improvement in anesthesia and in methods of approach, opening of the chest need not be attended with more danger than that which

accompanies any major operation. In this connection also, Adler's far-sighted recommendation is to be recalled.

The presence of a bloody pleural effusion not otherwise accounted for is strongly suggestive of intrathoracic malignancy, but in such a case the condition has usually already reached a hopeless stage.

TREATMENT

The treatment to be recommended depends, of course, upon the extent of the growth at the time the definite diagnosis is made. For tumors which have already gone well beyond their original confines, palliative treatment of symptoms is almost all that remains to be done. In fact many writers dismiss the question of treatment with the above suggestion, stating that so far as it is concerned the condition is hopeless. The recent increase in frequency and advances in thoracic surgery have brought renewed interest from clinicians and this in turn renewed efforts toward some curative procedures. Brunn collected reports of 28 cases in which operations had been performed and reported two of his own. On many of these the operations in themselves accomplished little, because of metastases already present or because of inaccessibility which made complete removal impossible. Included in this group, however, were 5 cases in which Sauerbruch operated, and 2 of the patients were still alive and apparently well, 5 years and the other 3 years after operation. In some others a fatal pneumonia supervened when it was thought a complete extirpation may have been accomplished. In other instances patients lived for as long as a year and a half before metastatic tumor or local recurrence brought about a fatal termination.

Harrington has recently reported operations on 14 patients with intrathoracic malignancy. Of these, 6 were diagnosed as sarcoma, 2 as endothelioma, 4 as adenocarcinoma, and 2 as squamous cell epithelioma. Six of these patients apparently had carcinoma which originated in the lung. Of these, 2 on whom partial lobectomy was done were alive less than a year after operation. Two others had partial lobectomies for adenocarcinoma and died in



Fig 5 X-ray plate taken August 12, 1931. The haziness of the right thorax persists and there are no signs of recurrence or of metastases.

less than a year of recurrence. Of 2 patients with endothelioma, 1 survived less than a year and the other more than 2 years.

These results, meager as they are, have changed the condition from one of absolute hopelessness, to one in which at least some effort may be made if operation is done reasonably early. As Weller has said "the stage at which carcinoma of the lung is diagnosed has already been moved back from the autopsy room to the last few months of life." This, of course, is not always true but it indicates some progress.

For tumors located well out in the periphery or midportion of a lobe, extirpation of the tumor or a lobectomy, after a wide exposure would seem to offer the best chance for a cure. It is only reasonable to consider that at some stage no metastases have occurred and that removal of the tumor will eradicate the disease. The crux of the matter lies in an early diagnosis. Whether keener observation and



Fig. 6. Photograph of removed lobe. Incision has been made through lung and tumor and portions held apart. On right may be seen tumor invading the bronchus, A on the left the main portion of tumor, B.

more adequate use of mechanical assistance will bring this about will provide an interesting study some years hence. As pointed out by Graham the radical operation offers scant hope of cure at present because of the advanced stage at which the diagnosis is usually made.

The cautery lobectomy has been used in a few instances where resection was not feasible. It would seem to be most applicable in those cases in which the tumor had spread into an adjacent lobe or where infection has supervened as so frequently follows the obstruction of a bronchus.

Vinson has recently briefly reported some results from the use of radium and deep X-ray therapy in bronchial carcinoma. Of 10 patients observed over periods varying from 4 months to 3½ years, 6 were reported as falling rapidly 2 were not heard from, and 1 was reported as apparently well. This last one had had treatment both with radium and X-ray 3½ years previously and the writer felt that this type of therapy should be

adopted. Others are strongly of the opinion that this type of treatment has been of no value.

REPORT OF CASE

We present herewith a report of a case of primary carcinoma of the lung on whom operation was performed following the establishment of the diagnosis by bronchoscopic biopsy.

A. S., a white woman, aged 65 years, was referred to one of us (F. J. S.) April 29, 1930, by Dr. John Nagle with a history of having had a slight irritating cough for the preceding 3 years. The onset of the trouble was dated as following a course of Pasteur treatment for dog bites. Shortly after the onset of cough she began to have some mucoid sputum which had never become purulent but which for the 2 to 3 months preceding her coming to the hospital had at times been pink stained. For the preceding 6 months she had been uncomfortable when lying on her right side and for the preceding months this symptom had become considerably aggravated. At the time Dr. Nagle was consulted the sputum was found negative for tubercle bacilli but an X-ray taken in April, 1930, revealed a rounded shadow at the base of the right lung.

On admission to the hospital, she appeared to be in good physical condition and, in fact, aside from a moderate hypertension and the findings in the right chest, the examination was essentially negative. The examination of the chest revealed nothing remarkable in the left lung. On the right side, a slight impairment of the percussion note with a diminution of the breath sounds was noted at the base. Both lung bases descended well and equally and the chest wall moved freely on both sides. No rales were heard.

Examination of the heart was negative.

Abdominal examination was negative except for slight tenderness over the gall bladder area. The liver edge could be felt on deep palpation, was smooth and not tender.

X-ray films of the chest revealed an oval shadow of increased density lying apparently in contact with the diaphragm. Films in the lateral position showed the shadow lying just posterior to the highest portion of the diaphragm. On fluoroscopic examination, the shadow descended with the diaphragm on deep inspiration and could not be separated from it by changing positions.

The possibility of the condition being an echinococcus cyst was considered and 150 cubic centimeter of echinococcus fluid was injected intradermally without reaction.

The sputum was negative for tubercle bacilli but contained streptococcus viridans, hemolytic streptococcus, and staphylococcus. The red blood count was 4,500,000 white blood count 7,600, and hemoglobin content 90 per cent. The blood Wassermann

reaction was negative. The urine and stool analyses were negative.

On May 5, a bronchoscopic examination was done by Dr George Kreutz. The instrument was passed directly into the right lower bronchus and as the terminal portion of this was approached a red fungating mass of a raspberry appearance was visualized. The marked bronchial irritation did not permit the taking of a specimen. On May 9, bronchoscopic examination was repeated and a bit of tissue easily removed from the tumor mass. Dr F W Hartman examined this tissue and described it as being composed of groups of mucous glands with masses of large oval and cuboidal cells having no particular arrangement. The cells had large hyperchromatic nuclei but these were not abundant. The diagnosis was primary carcinoma of the lung of the undifferentiated cell type.

With the diagnosis established and with no signs of metastatic tumors, an exploratory thoracotomy was advised, with the idea of resection of the involved lobe if this proved feasible.

The patient was discharged from the hospital and was readmitted for operation May 26. On May 28, after another 48 hour period of observation, the first of the two stage operation was performed. At this time portions of the sixth, seventh, eighth, and ninth ribs on the right side were resected, through an incision beginning in the midscapular line and running downward and laterally to the midaxillary line. The soft tissues were retracted, and with the lung kept well expanded by increasing the pressure of the ethylene and oxygen mixture, the thorax was opened. The lower lobe could be easily palpated and in its midportion there was felt a round firm mass about an inch and three quarters in diameter completely surrounded by lung tissue and entirely free from the lobe above and from the diaphragm below. The parietal pleura was slightly scarified with gauze on the finger to promote formation of adhesions, the pleura of the middle lobe sutured to the parietal pleura by a row of interrupted plain catgut sutures and the wound closed in layers. It seemed quite likely at the time that resection would be possible.

Following the operation the patient suffered a fair amount of shock. The pulse rate rose to 120 per minute and the temperature to 100.4 degrees. A transfusion of 650 cubic centimeters of citrated blood was given with considerable improvement. The patient continued to have considerable discomfort in the chest with some respiratory embarrassment but by the eighth day after operation the temperature and pulse rate were normal. On the twelfth day after operation the second stage of the operation was performed. Under nitrous oxide gas and oxygen anesthesia the wound was opened. About 300 cubic centimeters of slightly bloody fluid was evacuated. The upper portion of the chest was only partially sealed off by fragile adhesions and these also surrounded the lower lobe. With the lung kept moderately well expanded by the gas, the lower lobe was held in the palm of the hand, and the root of the



Fig 7 Photograph showing the scar of operation extending from midscapular to midaxillary line

lung was visualized. With the fingers and thumb placed well beyond the tumor, the pedicle was crushed in three portions and cut across with the radio knife. Each portion was then transfixed and ligated with chromicized catgut. The end of the stump was treated with electrocoagulation and its two outer portions then sutured together over the midportion. A single rubber tube was brought out through the chest wall through a small stab wound below the incision and the incision was closed in layers. The air was evacuated and the end of the tube placed in a water seal. The patient was in considerable shock on returning to her room. This was somewhat relieved by a blood transfusion. The respiratory embarrassment which was considerable was greatly relieved by placing the patient in an oxygen tent. While the immediate reaction was somewhat stormy, the convalescence was on the whole quite good. The temperature ran an elevation of 1 to 2 degrees for about 6 weeks after which it remained approximately normal. Recovery was complicated somewhat by an arthritis of the right shoulder, wrist, and hand so that getting the patient on her feet again was a somewhat drawn out process. During this time the lung had gradually expanded to occupy the dead space, the tube had been removed, the wound being well healed. The patient discharged September 8, 3 months after the last operation, having been afebrile for preceding month.

Three weeks after returning to her home she developed a swelling and redness of the operative scar



Fig. 6. Photograph of removed lobe. Incision has been made through lung and tumor and portions held apart. On right may be seen tumor involving the bronchus, *A* on the left the main portion of tumor *B*.

more adequate use of mechanical assistance will bring this about will provide an interesting study some years hence. As pointed out by Graham the radical operation offers scant hope of cure at present because of the advanced stage at which the diagnosis is usually made.

The cautery lobectomy has been used in a few instances where resection was not feasible. It would seem to be most applicable in those cases in which the tumor had spread into an adjacent lobe or where infection has supervened as so frequently follows the obstruction of a bronchus.

Vinson has recently briefly reported some results from the use of radium and deep X-ray therapy in bronchial carcinoma. Of 10 patients observed over periods varying from 4 months to 3½ years, 6 were reported as falling rapidly 2 were not heard from, and 1 was reported as apparently well. This last one had had treatment both with radium and X-ray 3½ years previously and the writer felt that this type of therapy should be

adopted. Others are strongly of the opinion that this type of treatment has been of no value.

REPORT OF CASE

We present herewith a report of a case of primary carcinoma of the lung on whom operation was performed following the establishment of the diagnosis by bronchoscopic biopsy.

A. S. a white woman, aged 65 years, was referred to one of us (F. J. S.) April 29, 1930, by Dr. John Nagle with a history of having had a slight irritating cough for the preceding 3 years. The onset of the trouble was dated as following a course of Pasteur treatment for dog bite. Shortly after the onset of cough she began to have some mucoid sputum which had never become purulent but which for the 2 to 3 months preceding her coming to the hospital had at times been pink stained. For the preceding 6 months she had been uncomfortable when lying on her right side and for the preceding 3 months this symptom had become considerably aggravated. At the time Dr. Nagle was consulted the sputum was found negative for tubercle bacilli but an X-ray taken in April, 1930, revealed a rounded shadow at the base of the right lung.

On admission to the hospital, she appeared to be in good physical condition and, in fact, aside from a moderate hypertension and the findings in the right chest, the examination was essentially negative. The examination of the chest revealed nothing remarkable in the left lung. On the right side, a slight impairment of the percussion note with a diminution of the breath sounds was noted at the base. Both lung bases descended well and equally and the chest wall moved freely on both sides. *N* riles were heard.

Examination of the heart was negative.

Abdominal examination was negative except for slight tenderness over the gall-bladder area. The liver edge could be felt on deep palpation, was smooth and not tender.

X-ray films of the chest revealed an oval shadow of increased density lying apparently in contact with the diaphragm. Films in the lateral position showed the shadow lying just posterior to the highest portion of the diaphragm. On fluoroscopic examination, the shadow descended with the diaphragm on deep inspiration and could not be separated from it by changing positions.

The possibility of the condition's being an echinococcus cyst was considered and 1½ cubic centimeter of echinococcus fluid was injected intradermally without reaction.

The sputum was negative for tubercle bacilli but contained streptococcus viridans, hemolytic streptococcus, and staphylococcus. The red blood count was 4,500,000 white blood count 7,600, and hemoglobin content 90 per cent. The blood Wassermann

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Fig. 8. Low power photomicrograph showing the lung invaded by alveoli of small undifferentiated tumor cells.

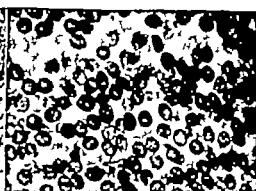


Fig. 9. High power photomicrograph showing the character of the individual tumor cells.

and was again admitted to the hospital. A small empyema pocket was found and was treated by the introduction of a tube and irrigation with Dakin's solution. There was no febrile reaction associated with this complication. It cleared up promptly and the patient was discharged from the hospital after 10 days.

The progress since then has been satisfactory. When examined recently 14 months after the last operation the scar was in good condition and had fallen in somewhat. There was considerable limitation of movement on the right side. The vocal fremitus and percussion note were somewhat diminished below the angle of the scapula and the breath sounds were distant. No rales were heard. There was a slight displacement of the heart to the right. X-rays of the lungs which were taken at this time showed a slight haziness over the entire right chest, but there were no signs of recurrence or of metastases.

Clinically the patient is well. Her cough has been entirely relieved and there is no sputum. She has gained weight and is pursuing her usual occupations as a housewife.

NOTE.—Patient was last seen in May 1932, and progress was entirely satisfactory. She is having no symptoms referable to the respiratory system, is carrying on her daily activities as a housewife, and so far as we have been able to determine there are no signs of metastases or of recurrence.

CONCLUSIONS

The interest in this condition of those engaged in clinical work has in the past been more or less cursory. On the other hand, it has offered a great field for study by pathologists.

It is, as yet, entirely too early to anticipate the probability of a cure in this instance. We can only say that for 14 months the patient has apparently been cured. Had the condi-

tion been diagnosed while the tumor was much smaller we should feel much more optimistic about the final outcome. The hopeful circumstance, so far as these tumors are concerned, lies in the fact that in some instances they can be successfully removed, even in elderly individuals. The chances for a complete cure will depend on the location in the lung and the making of the diagnosis before metastases have occurred.

The advances in roentgenography and the use of the bronchoscope in expert hands have made earlier diagnoses possible. Bronchoscopy cannot be too highly recommended as an aid in arriving at a diagnosis in any obscure lung condition.

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Complications with recovery The 31 respiratory complications with recovery comprise one case of lobar pneumonia, 5 cases of bronchopneumonia, 21 cases of bronchitis, and 4 cases of pulmonary embolism

Twenty-two of these were in males, 9 were in females

The ages of the patients, according to decades, are shown in Table II

TABLE II—AGES IN DECADES—
RESPIRATORY COMPLICATIONS, RECOVERY

	Cases
First decade	1
Second decade	2
Third decade	2
Fourth decade	5
Fifth decade	6
Sixth decade	7
Seventh decade	4
Eighth decade	4

In 12 cases the operation was on the upper abdomen

Sixteen of the cases occurred between October and March

Pre-operative cardiac pathology was present in 4 cases, pre-operative pulmonary pathology, in 3 cases

Complications resulting in death The 32 respiratory complications with fatal ending comprised 3 cases of lobar pneumonia, 20 cases of bronchopneumonia, 7 cases of pulmonary embolism, and 2 cases of pulmonary oedema (at autopsy the cases of oedema showed healed tuberculous scars in one and chronic nephritis in the other)

Autopsy was performed in 13 cases and confirmed the clinical diagnosis In 4 of these, thrombi were found in locations other than the lungs (in the veins of the leg, scrotum, inferior vena cava, and the penprostatic veins) Twenty-three of the patients were males, 9 were females

The age distribution is shown in Table III

TABLE III—AGE DISTRIBUTION OF
RESPIRATORY COMPLICATIONS—DEATHS

	Cases
First decade	3
Second decade	2
Third decade	3
Fourth decade	1
Fifth decade	4
Sixth decade	11
Seventh decade	7
Eighth decade	1

TABLE IV—SUMMARY OF COMPLICATIONS

	Recoveries	Deaths
Lobar pneumonia	1	3
Bronchopneumonia	5	20
Bronchitis	21	0
Pulmonary oedema	0	2
Pulmonary embolism	4	7
Total	31	32

In 10 cases the operation was on the upper abdomen

Twenty-three of the 32 cases occurred between October and March

There was pre-operative cardiac pathology in 15 cases, pre-operative pulmonary pathology in 5 cases, and pre-operative cardiac and pulmonary pathology in 4 cases Lesions of the heart or lungs or of both heart and lungs had thus been present before operation in 24 of the 32 fatal cases, as compared with 7 of the 31 non-fatal cases of respiratory complications

It may be noted further that 19 of the 32 patients who died of respiratory complications were over 60 years of age, that 7 of 8 patients with bladder or prostate lesions were over 68 years old, and that 5 had elevated temperatures at the time of operation

Statistics from other hospitals Recent statistics in the literature are in many instances not wholly comparable for the reason that they are confined to certain types of operations, to certain kinds of anæsthesia, or to certain respiratory complications

Patey combined the statistics from 31 London hospitals for 1926 and found that in 54,253 operations there were 50 cases of pulmonary embolism, a percentage of 0.09 Forty-three cases followed abdominal operations

Aikenhead quotes Armstrong's report of 2,500 major operations in Montreal, with postoperative lung complications in 2.2 per cent, Featherstone's report of 222 gastric operations in Birmingham (England), with a morbidity of 10.8 per cent, Whipple's statistics from the Presbyterian Hospital of New York 3,719 operations with development of lung complications in 2.3 per cent, and Elwyn's 299 operations under some form of local anæsthesia at Mount Sinai Hospital, New York, with pulmonary sequelæ in 2.7 per cent

RESPIRATORY COMPLICATIONS FOLLOWING GENERAL ANÆSTHESIA

MARY LYONS, M.D. CHICAGO

Clinical Instructor at Lakeside, Presbyterian Hospital

THIS report is based on 6,619 operations in which general anesthesia was used. The data are taken from the records of the Presbyterian Hospital Chicago and cover the period from January 1, 1921 to December 31, 1930.

Sex. In 3,358 operations the patients were males in 3,361 females.

Age. The ages of the patients ranged from 2 hours to 92 years.

The anæsthetic. One thousand four hundred and fifty general anesthetics fall into the period before the discovery and clinical use of ethylene in April, 1923. The technique used during this time was nitrous oxide gas and oxygen induction followed by drop ether or ether only for infants, with no preliminary medication. From April 1923 to the end of the year 1930 5,169 general anesthetics were given. In 2,670 cases, ethylene was used alone in 2,245 ethylene and ether were used in 14 cases, local and ethylene in 82 cases, ethylene and local and ether in 98 cases, nitrous oxide gas and oxygen and in 110 cases nitrous oxide gas and ether.

Preliminary medication has been used since 1923. The following drugs, in the order named, were the most frequently employed morphine, morphine and atropine, pantapone rarely morphine and scopolamine.

Respiratory complications. Sixty three patients developed respiratory complications following these 6,619 operations. Forty five were males, 18 were females. Thirty-one of these patients recovered 32 died. These figures represent a morbidity percentage of 0.95 and a mortality percentage of 0.48 for the total series of 6,619 operations.

All patients in whom any lung complications developed within 30 days following the operation have been included. Many observers claim that respiratory complications due to the anæsthetic occur within 24 hours. No attempt has here been made to separate

those due to the anæsthetic from those due to other causes.

Thirteen of the cases of respiratory complications with 4 deaths, were in the 1,450 cases before April 1923 when ethylene began to be used 50 cases, with 28 deaths, occurred in the 5,169 cases of the later period (Table I). (The corresponding percentages are 0.89 and 0.96 for the morbidity 0.17 and 0.54 for the mortality.)

TABLE I.—ANÆSTHETIC AGENTS USED

Pre- April 1923	Ma. lung Complica- tions	Recoverd	Died
44 Ether only	4	1	—
44 Nitrous oxide and oxygen	4	3	—
112 Nitrous oxide and oxygen and ether	4	3	—
1,450	13	9	4
5,169	50	28	22
1,442 Ethylene and ether	18	10	8
14 Ethylene and local	—	—	—
8 Ethylene and local and ether	—	—	—
98 Nitrous oxide and oxygen	3	—	3
110 Nitrous oxide and ether	—	—	—
6,619 Total	60	37	26
6619	60	37	26

During this period 218 operations were performed on the breast 114 on the vagina, and 604 tonsillectomies with no respiratory complications. In 240 diabetic patients 8 developed lung complications, 5 who had bronchitis recovered and 3 died, one of lobar pneumonia, one of pulmonary embolism, and one of bronchopneumonia.

Thirty nine of the 63 respiratory complications occurred in the months from October to March.

From the standpoint of age, it may be of interest to note that the oldest patient of the total series (aged 92 years) who had nitrous oxide gas and oxygen for drainage of an appendiceal abscess did not have any respiratory complication while the youngest patient (a two hour old infant) who had ether anesthesia lasting 40 minutes for repair of a large ventral hernia, developed bronchopneumonia 3 weeks after the operation and died on the twenty ninth day.

(These anæsthetics were given at the services of Drs. Lurie, Fremont, David, Kohn-Jacob, Woodhead, Harbit, McCann, Montgomery, Miller, Chubbuck.)

there exists a familial type, with torpid, adipose asthenic habitus, which is predisposed to thrombosis and embolism. In such a subject, surgery could activate the thrombophilic factors through various means by the cardiac debility and the hypotension which usually follow operation, by producing changes in the composition of the blood (Diaz Sarasola noted certain morphological, serobacteriological, and physicochemical alterations in the blood of patients after operation, and Walters mentions changes in the cellular constituents of the blood after operation as being seemingly concerned in the origin of emboli), or possibly through noxæ provoking reactions in the endothelial cells of the vessel linings. Efforts have been made, but without much success, to link up the modern practice of intravenous administration of medicines with the increased prevalence of thrombosis and embolism. In Central Europe, war and postwar malnutrition have been blamed. Franke expresses the opinion that the present alarming increase may prove to be a transient phenomenon, bequeathed to the world by the influenza epidemic of 1918-1919, which, he suggests, has left behind a condition of latent infection whose point of attack is the vascular system.

Other probable causes of respiratory complications following operation are: Pre-existing cardiac or pulmonary disease, poor mouth hygiene, cooling-off of the patient, aspiration of stomach contents, decreased expectoration and poor ventilation of lung bases after operation because of pain, disorganization of the abdominal pump mechanism by an abdominal incision producing a tendency to stasis in the splanchnic vessels which predisposes to thrombosis, and pneumostasis from the patient lying continually in the dorsal position. In my experience, bronchitis is more likely to occur in heavy smokers than in those who do not smoke or who smoke only moderately.

Diagnosis The physical findings in the various lung complications are too well known to be repeated here, and the subject of diagnosis comes within the scope of this paper from only one angle. In reviewing the literature since 1924, one is impressed with the number of contributions dealing with respiratory sequelæ of surgical interventions, and

also by the apparent increase in their incidence. Is this increase an actual one or are we examining patients more thoroughly? Heep reminds us that an elevated temperature after operation used to be accepted in most cases as due to the general course of the operative wound, whereas we now know that it is most often caused by lung complications. In respect to the apparent increase in postoperative pneumonia, we may remember what Neuhoﬀ points out: "the diagnosis of pneumonia in very sick patients is fraught with difficulty." Aikenhead reports that of 81 cases that were diagnosed pneumonia clinically and that later came to autopsy, the post-mortem examination confirmed the diagnosis in only 51, or 60 per cent.

Prevention Since postoperative respiratory complications cannot in the present state of our knowledge be laid to the door of any one definite and certain cause, our hope of prevention must lie in meticulous care of the patient before, during, and after the operation. If the patient's heart is already damaged, it must be fortified by digitalis. Henderson found myocardial degeneration and decompensation in 23 of 46 non-surgical cases of pulmonary embolism. Chilling of the patient due to the soap and water preparation and to allowing the patient to remain on a pad that has become wet during this process is a source of danger that is sometimes overlooked. During the operation tissue injury must be kept to a minimum, especially must one use care when removing necrotic areas and hæmatomata.

The circulation requires special thought in the postoperative period. The effect of the operation itself is to tend to decrease the rate of blood flow and to lower blood pressure. Particularly do intra-abdominal manipulations interfere with the circulation. After the operation, the rest in bed and the muscular splinting of the abdominal wall because of pain act to slow down the blood flow. The first steps toward encouraging the circulation are directed toward assuring a sufficient amount of fluid in the vessels to make normal pressure and flow possible. To this end, saline or 5 per cent dextrose solution may be introduced by hypodermoclysis in quantities

The figures of Stahnke from the Brandenburg Clinic at Berlin show respiratory complications after 3.5 per cent of vaginal operations, after 14.2 per cent of laparotomies, 10.35 per cent of prostatectomies, 9 per cent of appendectomies, and 14.8 per cent of hernia operations.

Fuller analyzed the surgical records of University College Hospital, London, for the year 1927 and found 124 pulmonary sequelae in 1,478 cases, a percentage of 8.3 per cent; the mortality was 1.8 per cent. There were 75 cases of bronchopneumonia, a larger number he pointed out than in any of the recently published series. In most of the cases of bronchopneumonia, the onset was on the first or second day after operation; a few cases began on the third day; 1 on the fifth day. The series contains 9 cases of infarction; this complication, he says, never occurs before the seventh day.

Etiology. The exact process leading to the different types of respiratory sequelae of surgical operations seems to be unknown. The anesthetic agent in itself does not appear to be the determining factor, since these complications have occurred following local, spinal, rectal, and various forms of inhalation anesthesia. Stahnke claims a higher mortality from lung complications after gynecological operations when spinal anesthesia is used. Mikulicz (cited by Aikenshead) asserts that lung complications occur as frequently after local as after general anesthesia. It has not been shown that the length of the operation is a factor.

The site of operation, on the other hand, appears to be important. The percentage is high for laparotomies. This cannot be held to be due to operative shock, since Stahnke's figures quoted are high for prostatectomy, appendectomy, and especially so for herniotomy. In Aikenshead's series more than half the respiratory complications followed gastrointestinal operations including hernias.

Irritation in and about the structures supplied by the vagus is thought to be important, and the fact that a large proportion of the operations followed by pulmonary complications have been upper abdominal operations supports this view. In Fuller's series, 181

upper abdominal operations accounted for 41 lung complications, 22.6 per cent, whereas 429 lower abdominal operations were followed by pulmonary complications 47 times, only 10.9 per cent. In the present series, 22 of the 63 surgical interventions that gave rise to respiratory complications were upper abdominal operations. Nine were lower abdominal operations.

It is probable that pressure on the diaphragm from the Trendelenburg position maintained for a long time plays a part in producing lung complications. Saline injections given too frequently or repeated at too short intervals are another probable factor. Moynihan claims that acute edema of the lungs may be caused by large saline injections given for shock.

It is Razemon's opinion that the infecting organisms gain entrance by the lymphatic route and pass from the diaphragmatic lymphatics to the thoracic duct and the great veins of the neck, and thence to the right heart to be filtered out by the lungs. Crier and Hunt hold that infection is carried by small emboli through the lymphatics or by the blood stream from the site of operation to the lungs.

Foss and Kupp believe that embolism plays the chief part in the production of most post-operative pulmonary complications. They affirm that infarctions (minor emboli) are far more common than has been generally supposed. According to published reports, recent years have seen an astonishing increase in thrombosis and embolism in both Europe and America. Numerous theories have been advanced to explain this increase, but none has won general acceptance. Kuhn, of the Institute of Pathology at Freiburg, states that from 1924 to 1927 fatal embolism increased from 1.3 to 4.9 per cent, and that in 1927 thrombosis was found in every fourth body examined, fatal embolism in every twentieth. He thinks that the increase is to be explained by the prolongation of life in patients with chronic disease of the heart. He states also that thrombosis and embolism are three times greater in patients with chronic heart disease after cystotomy preliminary to prostatectomy than after the same operation on patients in good condition. Diaz Sarasola believes that

senting a morbidity of 0.95 per cent and a mortality of 0.48 per cent

2 Males are apparently more susceptible than females

3 All patients developing any respiratory complication within 30 days after operation are included in this report

4 There were 218 operations performed on the breast, 114 on the vagina, and 604 tonsillectomies, without a respiratory complication

5 In 201 fractures, only one patient developed a lung complication

6 Thirty-nine patients (61.9 per cent) developed lung complications during the winter months

7 In patients over 60 years of age, there were 19 deaths, 31 per cent

8 In 31 patients, 49 per cent, there were heart or lung lesions prior to operation, 24 of these died, and 7 recovered

9 Site of operation is a factor as shown by the following 22 cases, 34.9 per cent, following upper abdominal operations, 9 cases, 14.28 per cent, following lower abdominal operations (6 hernias), 9 cases, 14.28 per cent, following cystotomies and prostatectomies, 5 cases, 7.93 per cent, following kidney operations, and 18 cases, 28.57 per cent, following operations in other locations (see Table V)

10 There were no cases of postoperative atelectasis diagnosed

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TABLE V—SUMMARY OF STATISTICS

Operations	Cases	Bronchitis		Broncho-pneumonia		Lobar pneumonia		Emphysema		Others	
		Recovery	Death	Recovery	Death	Recovery	Death	Recovery	Death	Recovery	Death
Brain tumors	28										
Laryngeal papilloma, excision	7										
Cleft palate	28										
Foreign body—bronchus	20										
Thyroidectomy	473	2			2						
Mastoidectomy	53										
Stomach	22				2						
Exploratory laparotomy and intestinal	290										
Ovarian	234	2									
Appendectomy	700										
Abdomen—gynecology	30										
Heart—including postoperative	200	2									
Kidney	203	2									
Urinary bladder	209										
Prostatectomy	220				2						
Crural	26										
Rectal	120										
Fractures	004										
Caecitis of leg											
Amputation of leg	24										
Total	4719	11		5	00		2		4		

Total cases with complications
Cases without complications—

Brain
Lungs
Vascular
Circulatory
Outside patients
Miscellaneous

Total combined

4719

228
22
604
700
242
2200
0079

of 500 to 1000 cubic centimeters or by the rectal drip method. In obese patients, on the other hand, and in patients with a tendency to bronchial disturbances, the removal of from 100 to 300 cubic centimeters of blood from the circulation may prove beneficial. Inhalations of carbon dioxide (2.5 per cent) may be given to stimulate the respiratory center with consequent quicker removal of gas from the blood. The inhalations are continued for from 5 to 10 minutes and are repeated at half hour, one, or two hour intervals. To avoid stasis in the lung bases, care is taken that the patient does not lie too long in the dorsal position. Systematic bed exercises of the arms and legs, started as soon as prac-

ticable after operation have received some attention in recent years.

A large variety of drugs have been recommended in the prophylaxis of pulmonary complications, for their effect on the circulation, on the respiratory center and on expectoration of mucus from the air passages. The older drugs, such as caffeine, camphor, strychnine, etc., are well known and my experience with the newer preparations and combinations has not been wide enough to enable me to say anything of value.

SUMMARY

1. In 6,619 inhalation anesthetics, 63 patients developed lung complications, repre-

tree and did not find the parietal sacculi or vasa aberrantia to be increased in size or number in cases in which the gall bladder was diseased or had been removed. In cases of cholecholethiasis and benign and malignant stricture, the vasa aberrantia were tremendously enlarged and sacculated, corresponding in degree to the amount of dilatation of the duct, while the parietal sacculi appeared to be absorbed by the wall of the dilating duct.

In the study reported here I wish to ascertain the effects of absence of the gall bladder, absent either in function, having been rendered so by disease although still present anatomically, or absent in fact, having been removed by surgical operation. The physiological properties of the gall bladder, so far as is known, have to do mainly with the concentration of the bile which enters it and with regulation of pressure within the biliary system, in other words, it is a reservoir for bile, and concentrates and expresses bile into the duodenum for specific action on food (11, 13). Nothing definite is known at present as to its relation to metabolism of cholesterol. Filling of the gall bladder with bile is dependent on a functioning sphincter of Oddi, at the duodenal end of the common bile duct, as shown by Winkelstein and Aschner in 1926, when they inserted a small glass cannula into the papilla of Vater, thus keeping the sphincter patent, and it was found that all the bile flowed immediately into the duodenum, the gall bladder remaining completely collapsed.

Judd and Mann, and Mann later again, found that there was some dilatation of the extrahepatic part of the biliary tree after cholecystectomy, depending on an intact sphincter, and that this dilatation did not occur when the sphincter was destroyed. As to whether the biliary tree following loss of the gall bladder undergoes any changes which might have a tendency to compensate for this loss, or to enable it to take over its function, Judd has expressed the opinion that experimental evidence seems to show that this is not possible. He thought it more probable that when the gall bladder is missing the function of concentrating the bile is eliminated, for the bile does not become concentrated in the common duct. Results of Graham-Cole tests on pa-

tients without a gall bladder seem to substantiate this belief, also (9).

Mann and Potter noted an increase in the pressure in the common bile duct immediately after cholecystectomy.

Sutton in 1930 in a microscopic study of the injected bile ducts of the cholecystectomized dog came to the conclusion that parietal sacculi enlarge and their epithelium as well as the epithelium of the bile ducts, undergoes changes so that it comes to resemble the epithelium of the normal gall bladder.

METHOD

The work undertaken in this study was done partly with material obtained at necropsy, from unembalmed subjects dead less than 3 hours. Studies were made of both injected and uninjected specimens, exemplifying the normal structure in the human being, the youngest subject was a fetus of 5 months and other subjects were in old age. Livers of the monkey, dog, pig, rabbit and rat also were studied. In the injected specimens the method employed by Sutton was tried, but it was found that essentially better results could be obtained by omitting the injection of gelatin, and perfusing the organ with formalin while the specimen was fresh, thus fixing it quickly. Injection into the bile ducts of any gelatin-like substance, under pressure of 100 to 180 millimeters of mercury distends the walls of the ducts, and this has a tendency to efface all but the larger folds of epithelium lining the tracts. This very fact defeats the object of the study, that is, to find if possible the true reason for the formation of certain foldings or villous processes in the epithelium of the bile ducts. The cause of this evident change can be found and properly interpreted only by close study of the sacculi and their smaller, caecal diverticula, and such a study can best be made by examining many slides of serially sectioned ducts, both intrahepatic and extrahepatic. Otherwise, if a section is taken here and another there, and studied as representing the condition existing throughout the duct, many faulty opinions and erroneous ideas are sure to arise. After the preparation of many specimens by the injection method and their microscopic study by serial sections, it was found

CHANGES IN THE BILE DUCTS AND PARIETAL SACCULI FOLLOWING ABSENCE OF THE GALL BLADDER¹

FOREST W. COX, M.D. ROCHESTER, MINNESOTA

Fellow in Surgery The Mayo Foundation

KIERNAN in 1833 in his thesis on the anatomy and physiology of the liver gave the first comprehensive description of the intimate structure and functional activity of the liver and biliary system. He was the first to describe a few accessory gland-like structures found lying entirely within the walls of the ducts communicating with the lumen by numerous minute orifices. In the pig, sheep and horse they surrounded the wall completely anastomosing within it and opening on the lumen from all sides. In man, however they were arranged in two rows, on opposite sides of the ducts, with the orifices preserving the same relationship.

Theile, in 1844, by means of similar injections, observed that these structures consisted of branching clusters, terminating frequently in small caecal diverticula. He considered them mucous glands comparable to the meibomian glands of the eye.

Beale, in 1856 and again in 1889 after extensive researches devoted to the subject, confirmed and extended the observations of Kiernan and Theile. He was the first to attach the term "parietal sacculi" to the mucous glands of Kiernan and Theile, considering them ductal diverticula rather than mucous glands. He found that they occurred in the common and hepatic ducts, and in all of the intrahepatic branches as far distal as those measuring $1/125$ of an inch (0.2 millimeter) in diameter. He found also that although anastomosis between parietal sacculi frequently occurred within the walls of the ducts, quite as often it took place outside them and within the parenchyma of the liver by means of irregular canals springing from the terminal caecal diverticula. Beale thought these sacculi should be regarded as diverticula in which the bile may be retained temporarily while it becomes inspissated and probably undergoes other changes. In fact, he wished to regard them as supplementary little gall bladders appended to the ducts.

Holmes in 1911 describing the mucous glands of the bile ducts and gall bladder quoted Sappey's description of a system of accessory ducts connected with the bile ducts proper. He called these "vasa aberrantia" or "vaginal bile ducts" of the liver although these were first noticed and named by Weber. Sappey thought these to be either of vestigial embryonal origin or that they appeared in the process of postnatal atrophy affecting a portion of the liver.

However parietal sacculi and vasa aberrantia assume importance if considered in the light of work by Sweet, in 1924, when he reviewed the work of Beale and further contributed to the subject. If according to the hypothesis of Beale, these structures were to be considered as accessory small gall bladders, then they should show some change, either functional or anatomic, following cholecystectomy. In animals without the gall bladder such as the horse, Sweet found the sacculi to be large and numerous, whereas in animals with gall bladders they were flattened and inconspicuous. In dogs, after cholecystectomy he noted an immediate rise in the value for cholesterol in the blood, which returned to normal after 40 days, and was considerably below normal in 74 days. Coincident with the fall in cholesterol of the blood, the parietal sacculi enlarged and became hypertrophied. He, therefore believed that these structures took over the function of absorbing cholesterol from the bile, which Boyd has demonstrated in the normal gall bladder. In other words, that the parietal sacculi were actually subsidiary gall bladders.

Counselor in 1928, substantiated the belief in the tortuosity and branching of the vasa aberrantia, and noted the curious fact that in the human being practically all the branches of the biliary tree and the vasa aberrantia arise from opposite sides of the duct along the lines of the parietal sacculi. He showed the dilating effects of obstruction in the biliary

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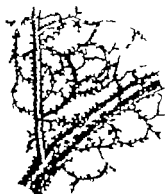


Fig. 1 Bile ducts with anastomosing vasa aberrantia and parietal sacculi (Sappey)



Fig. 2 Normal intrahepatic bile duct of a dog

that the state of affairs in the natural, undistorted structures could best be learned by practically instantaneous fixation of the tissue by perfusion with formalin, and no subsequent injection of the ducts.

The experimental side of the problem consisted in performing cholecystectomy on a series of normal dogs. The animals were then killed at periods of 30, 60 and 90 days after operation and the livers perfused with formalin. Also the common ducts of rats, which possess no gall bladder were ligated and the rats killed 8 days after operation others were allowed to die and death occurred in about 18 days.

OBSERVATIONS

Thirty days after cholecystectomy definite changes were noted in all the extrahepatic bile ducts of the dog. These changes were in direct proportion to the dilatation of the ducts. The intrahepatic ducts, situated in the liver proper and supported on all sides by this non-distensible tissue, were conspicuous in their failure to show the changes which were so evident in their continuations outside the hepatic substance.

A diagrammatic scheme of the extrahepatic bile duct together with the parietal sacculi and the system of vasa aberrantia, or vaginal bile ducts, is best described by Sappey (Fig. 1).

The normal intrahepatic bile duct of the dog is lined with tall columnar epithelium, as is the gall bladder (Fig. 2). Around the lumen

of the duct parietal sacculi, cut at varying levels, are shown. Of these, one, *a*, is cut exactly through the orifice by which it opens into the duct, and the others, *b* and *c*, not quite through the orifices. On the upper side of the duct is a sacculus, *c*, cut at a level giving an appearance as though it might have no direct connection with the duct. Around the extrahepatic bile ducts, as well as in their walls, particularly the wall of the common bile duct, these structures are much more numerous, anastomosing with each other presenting small cecal diverticula, and some having aberrant bile ducts leading from them.

Marked changes had taken place in the common hepatic bile duct of a dog within 30 days following cholecystectomy. Dilatation of the sacculi was apparent and the so called folding or villus-like projections had made their appearance (Fig. 3). At *a* a dilated sacculus was sectioned just through the margin of its opening into the main duct. In the next serial section the level of the cut was directly through the opening into the sacculus so that two villi, similar to that at *c* were produced. At the point *d* an adjacent sacculus was sectioned close to its ostium. *b* and *e* appear in the figure as two independent sacculi, and yet serial sections of them showed clearly that *e* emptied into *b* and that *b* opened directly into the lumen of the duct. Sacculi *e* and *b* were continuous with each other and with the main duct through the ostium of sacculus *b*. The irregularities appearing within the sacculi are



Fig 3 Common hepatic duct from dog 30 days after cholecystectomy

smaller cæcal pouches cut through their similarly dilated openings. These cæcal diverticula are in evidence around the sacculi and duct, appearing as gland-like structures, but in reality they are sacculi cut at levels other than through their orifices.

At 60 days following operation, numerous sacculi surrounding the hepatic duct gave evidence of dilatation, and so-called villous processes projected into its lumen (Fig 4, A and B). When serial sections are followed however it appears that fold *a* and *a'* and fold *c* are not villi but are merely the walls of enormously distended sacculi, for these folds, in adjacent sections (Fig 4, B), meet, fuse, and form the definitely isolated sacculi. Furthermore, comparable conditions were encountered in the aberrant bile ducts, as shown in the left side of each figure. It is not difficult to see how a single section, taken as a criterion by which to judge the true formation in the ducts, would be entirely misleading. It is also easy to see how distention of these structures with a semisolid substance under high pressure would have a tendency to distort the real picture.

A section of the common bile duct of a dog, operated on 90 days before, illustrates the extent to which this system of sacculi may develop (Fig 5 A). As one traces the biliary tract upward from the duodenum, these become decreasingly numerous as the periphery of the liver is reached. The structures which appear as folds or villi in the section are but



Fig 4 A, Hepatic duct of a dog 60 days after cholecystectomy, B, serial in sequence from same duct as A

cross sections of the openings of the dilated sacculi and their adjoining cæcal diverticula.

A section of the hepatic duct of a rat, the bile duct of which had been ligated 8 days,



Fig 5 A Common duct near the duodenum of a dog cholecystomized 90 days, B, intrahepatic bile duct of dog cholecystomized 90 days. Scharlach R stain for lipid



Fig. 1. Bile ducts with anastomosing vasa aberrantia and parietal sacculi (Sappey)

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is a similar arrangement, and at *b*, an aberrant duct or deep saccule with caecal diverticula extending from its lumen, giving the appearance of folds between them. In this case, 4 days after operation, it is manifestly improbable that these folds had arisen as a result of hyperplasia in consequence of the recent cholecystectomy. It is more likely that they were the result of the lost reservoir capacity of the diseased gall bladder which had been removed.

It is impossible, in this brief presentation, to consider all cases in which I have examined pathological changes in the biliary structures, consequently, only one of the cases in which cholecystectomy was performed has been described. However, similar findings were present in all cases studied at necropsy, and the results were practically constant in those cases in which marked increases in intraductal pressure were manifest. Infection has to be taken into consideration, but in an affirmative rather than in a negative way. A dog's cystic duct, the site of severe infection, and with mucopurulent material practically obstructing it, presents the same appearance of folds from dilated sacculi as are found in other forms of obstruction or increased pressure within the ducts.

A diagnostic scheme perhaps most adequately illustrates the sequence of events in dilatation of biliary ducts from intraductal pressure (Fig 8). Part I of Figure 8 represents a primary bile duct *C* with parietal sacculi *B* and a small caecal pouch *A*, the latter not seeming to communicate with *B*. Under the influence of increased intraductal pressure, from whatever cause, such as obstruction from calculi, from carcinoma of the head of the pancreas, or from loss of the gall bladder either by operation or by disease, changes are induced such as are represented in part II. This shows the communication between *A* and *B*. The orifice of *B* opening into duct *C* is widening, and the section makes the two opposite lips of the ostium of the saccule appear as two folds projecting into the lumen of duct *C*. In part III the condition is a little more marked even the small orifice of *A* appearing as though bounded by two minute folds. The next part, IV, of the drawing is simply a step further in the process, and is probably as far as the dila-

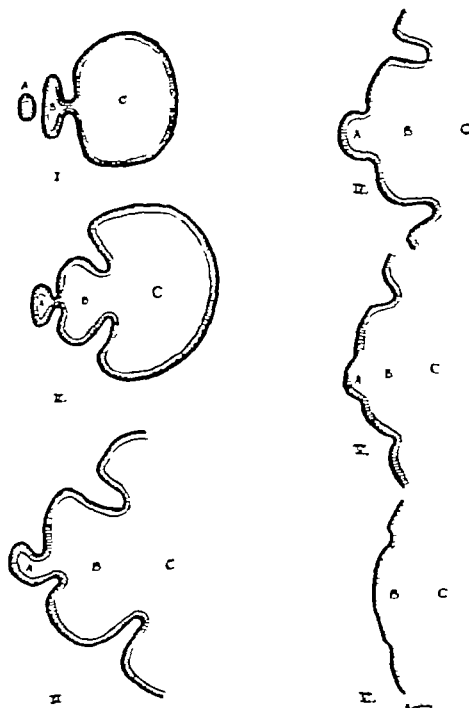


Fig 8 Sequence of events in production of dilatation of biliary duct (Humphrey)

tation would ever go in uncomplicated cholecystectomy. If the obstruction is caused by carcinoma of the ducts, or of the head of the pancreas, or by impacted calculi completely blocking the common bile duct the process passes rather rapidly through the first four stages into a condition represented in part V. The last stage represents the condition in a severe dilatation from obstruction, and can be experimentally produced in a rat by ligation of the common bile duct. This is the stage in which dilatation has progressed as far as possible, and the steadily increasing pressure had flattened the once tall columnar epithelium until it is low cuboidal in type. This last appearance is what would be the inevitable and constant result if the sacculi and vasa aberrantia were not present to distort the picture, as revealed in the figures of bile ducts from cholecystomized dogs.

DEDUCTIONS

The questions to which I have endeavored to find answers resolve into the following. Are



Fig. 6. Portion of cross section of wall of hepatic duct of human being 4 days after cholecystectomy



Fig. 7. Another portion of wall of same duct as shown in Figure 6.

presents essentially identical conditions. The rat possesses no gall bladder but as shown by Higgins, has a secondary plexus of bile ducts surrounding the branches of the portal vein. In the common duct of a rat, ligated 18 days, the duct was dilated from a diameter of 1 to 2 millimeters to one of 2.5 centimeters. The lining epithelium in this case was flattened greatly and all sacculi had disappeared.

In a dog subjected to cholecystectomy 90 days before the epithelium of all hepatic ducts took a heavy brilliant red when stained with achroslach R for lipoid (Fig 5 B). This lipoid has the double refractility of cholesterol when examined by Nicol prisms, but on fractional analysis is shown to contain of a total of 22 per cent fat only 0.6 per cent cholesterol or in a proportion of 1 to 40. This increased deposit of lipoid in the biliary epithelium seemed to be constant in all the dogs used in this work. In normal dogs this did not seem to be the case and in a dog operated on one year before, the condition was much less marked. However no attention was paid to how recently the dogs had been fed, although none of them had been fasted. This lipoid was present in the epithelium of all the hepatic ducts sacculi and aberrant ducts, even to the smallest biliary tubules, as shown in Figure 5 B. Gall bladders of human beings, the site of cholesterol, differed from those of dogs in that the greatest amount of lipoid appeared to be in the subepithelial tissue whereas in the bile ducts of these dogs which had been sub-

jected to operation it was confined almost entirely to the epithelium. The term "cholesterosis" however seems a misnomer for the condition "liposis" is more descriptive of the true state of affairs.

A number of observations have been made on bile ducts of human beings taken at necropsy within a relatively short time after death, wherein various pathological conditions had induced changes in the biliary system. Of these, a group of cases was observed in which operative cholecystectomy had been performed at some time, the most recent one 4 days before, and the oldest one, 9 years and 4 months before. Other patients had no operative cholecystectomy but had experienced interference with the reservoir capacity of the gall bladder owing to the presence of stones, or of disease without stones, amounting in some instances to what one might term complete loss of function. Studies were made of three cases of malignant obstruction of the bile ducts in which the gall bladder was apparently in good condition.

In hepatic ducts of a patient who had undergone cholecystectomy 4 days previous to examination conditions were encountered resembling markedly those described for the dog (Figs. 6 and 7). Definite folds are shown, but these are only the walls of a dilated saccule cut through its orifice at *a*. Just to the left, at *b* (Fig. 6) is either a separate saccule or a part of the one marked *a* so sectioned as not to show its ostium in the duct. In Figure 7 at *a*,

sections stained with mucicarmine, they never contain mucus in any greater degree or amount than the cells lining the main ducts and gall bladder

From the standpoint of clinical and practical application, the findings in this study resolve themselves into those changes contingent on increase in pressure in the biliary ductal system, from any cause whatsoever, the extent of these changes being in direct proportion to the degree of the obstruction. The increased tension following cholecystectomy is one which progresses until equilibrium is established between the dilating ability of the elastic tissue in the wall of the ducts and the point at which the pressure is such as to overcome the sphincteric mechanism at the duodenal end of the common bile duct, at which time the bile is expelled into the intestine. In other words, if this sphincteric mechanism, which is necessary to fill the gall bladder, were not present, and the bile had a free, unobstructed pathway into the intestine, there would be no dilatation of the biliary ductal system and consequently no distention of the sacculi

SUMMARY AND CONCLUSIONS

1 The villus-like folds found in the bile ducts following cholecystectomy are dependent on the presence of sacculi, or vasa aberrantia, in the walls of the ducts

2 These villi are not hypertrophied folds of epithelium, but the walls or lips of the dilated sacculi, or vasa aberrantia, sectioned through the orifice by which they communicate with the main duct

3 These folds do not appear in the intrahepatic ducts following cholecystectomy as they do in the extrahepatic ducts which can dilate easily, consequently, there seems to be no evidence that the ducts and sacculi take over the functions of the lost gall bladder. If the latter were the case these changes should be noted in the entire system of ducts simultaneously

4 Obstruction of the bile ducts, with a normally functioning gall bladder present, produces these same changes, and if superimposed on an operative or spontaneous cholecystectomy it accentuates them. Severe obstruction will produce very bizarre appear-

ances of the bile ducts, even those supported by hepatic parenchyma or dense connective tissue

5 Identical changes can be produced by ligation of the common bile duct of the rat, which does not possess a gall bladder, but does possess a system of sacculi and secondary bile ducts

6 There does not seem to be any epithelial activity, as regards hypertrophy or hyperplasia, in response to any physiological demand

7 The changes are brought about mechanically by intraductal pressure from obstruction, or from loss of the reservoir and expansile properties of the gall bladder

8 Obstruction by carcinoma or by calculi impacted in the common bile duct and allowed to remain, produces effacement of the sacculi, dilatation of the ducts and vasa aberrantia, and finally flattening of the epithelium from columnar to a low cuboidal type

9 There do not seem to be any true mucous glands in the walls of the common bile duct, from the point of entrance into the duodenal wall, up through the hepatic and intrahepatic ducts, the only structures present are parietal sacculi and vasa aberrantia, lined with the same type of epithelium as the ducts, and having the same functions

10 Appended to the biliary ducts are parietal sacculi and vasa aberrantia. These latter may take origin from a sacculi or directly from the duct itself. They may or may not anastomose with another similar structure over rather long distances

11 A parietal sacculi may be a simple evagination or may have secondary caecal diverticula arising from it and communicating with its lumen

12 This phase of intraductal pressure may play an important part in infections of the biliary tract, and in the disturbance of metabolic functions of the liver if the organ is already badly diseased

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there any structures along the bile ducts which tend to assume the functions of the gall bladder in its absence? Do the parietal sacculi and vasa aberrantia in the absence of the gall bladder undergo hypertrophy and carry on inspiration of bile? Hitherto changes have been noted in the lining epithelium of the extrahepatic bile ducts, interpreted as a reaction on the part of those structures to enable them to assume the anatomical appearance of the epithelium of the gall bladder and, along with this change, to assume also its physiological functions. These questions have been answered rather affirmatively by some workers, using dogs in their experiments, but no study has been made so far as I am aware of such changes in man.

The changes which have been noted following cholecystectomy in dogs should of necessity appear simultaneously in all the bile ducts, both intrahepatic and extrahepatic. As shown in the microscopic sections of bile ducts of cholecystectomized dogs killed at periods of 30, 60 and 90 days after operation, these changes are constantly noted in the extrahepatic ducts, but never in the intrahepatic ducts, that is, those completely surrounded by hepatic parenchyma. If cholecystectomy was not accompanied by obstruction. In one dog which had undergone cholecystectomy 1 year before, but with added obstruction and infection severe enough to result in practically complete atrophy of one lobe of the liver these changes were noted in the intrahepatic ducts also but only in those in which the sections passed through parietal sacculi or vasa aberrantia. Therefore, the extrahepatic ducts, which are easily distensible are the situations most propitious for the development of these changes. The alternating dilatation from distention with bile held back by a functioning sphincter of Oddi, and the subsequent recoil by the elastic tissue in the wall of the duct when the sphincteric mechanism is forced to let go is the method by which these changes are wrought.

I have never been able to find mitosis, or other evidence of hyperplasia, and the apparent increase in the height of the epithelial cells lining the ducts and sacculi, is, I believe, due to the recoil of the elastic tissue in the wall of

the duct. In the extrahepatic bile ducts of the rat which has no gall bladder similar conditions were noted on the increase of tension due to ligation of the common bile duct. When the duct of the rat was ligated for 18 days, conditions corresponding to those seen in malignant obstruction in man were encountered.

In man these changes were likewise found following cholecystectomy and were more noticeable if obstruction was superimposed. They are also found if obstruction is the only pathological condition and if the gall bladder is present and functioning. It would appear that dilatation resulting from increased intraductal tension is the more probable theory which can safely and accurately account for the changes in the biliary ductal system. Following cholecystectomy both clinically and experimentally there is gross dilatation of the extrahepatic ducts, as well as a slight increase microscopically in the amount of elastic tissue in the walls of the ducts.

In most textbooks on histology wherein the biliary ducts are described, there is usually reference to and illustration of the "glands of the ducts." From the serial sections of the common bile duct where it enters the duodenal wall on up through the hepatic and intrahepatic bile ducts in man and dog and rat the only structures present in the walls of the ducts which might be interpreted as mucous glands, are the parietal sacculi with their caecal diverticula or vasa aberrantia. These structures, when sectioned at levels not showing their communication with the lumen of the main duct resemble glandular elements, but if studied and traced through numerous serial sections, they will be recognized. They do not resemble true glands, they dilate just as do the bile ducts, from obstruction, and the epithelium exhibits the same fat-absorptive properties as that of the epithelium of the bile ducts and gall bladder. These facts, taken in consideration with the apparent increase of the structures in cases of portal cirrhosis, seem to demonstrate rather satisfactorily their ductal properties and relationship and that there are no such structures as true mucous glands of the bile ducts. True their lining epithelium secretes mucus, and so does the epithelium of the ducts and gall bladder but as shown by

MAGGOTS AND THEIR USE IN THE TREATMENT OF CHRONIC OSTEOMYELITIS¹

JOSEPH BUCHMAN, B S, M D, F. A. C. S., NEW YORK

From the Orthopedic Service of Dr. Samuel Kleinberg Hospital for Joint Diseases, New York City

JOHN E. BLAIR, Ph D., NEW YORK

From the Laboratory Division of the Hospital for Joint Diseases, New York City

THE gift to observe accurately is given to few, but the gift to interpret observations properly and to apply them effectively in the solution of confronting problems is given to only an occasional student. Ambrose Paré (1509-1590) was the first, so far as is known, to note the beneficial effects of maggots in suppurative wounds. Hieronymus Fabricius (1634) also noted the effect of maggots on wounds. Zachmann (1704) made the first attempt to explain the origin of maggots in wounds. J. Larrey (1766-1842), a famous military surgeon of the Napoleonic armies, observed maggots in the wounded, and J. G. Millingen made a similar observation in 1809. More recently, in the United States, Shafer, Crile, and Martin spoke of this disgusting infestation and noted its beneficial effects, while W. W. Keen called attention to its occurrence during the Civil War. These are apparently the only notes in the medical literature concerning maggots in suppurative wounds. In modern hospital practice, such infestations occur from time to time and are looked upon with disgust and shame. Many surgeons have seen maggot infested wounds but few have realized their possibilities.

J. F. Zacharias, of Cumberland, Maryland, a surgeon in the Confederate Army, was apparently the first to utilize maggots successfully in the treatment of suppurations. His experiences, however, seem to have been forgotten until they were duplicated by the late William S. Baer. To our knowledge, Zacharias and Baer are the only observers who have realized the significance and possibilities of the use of maggots and are the only ones who have made a practical application of this agent in the treatment of suppurative wounds, a method new in principle, for here neither physical nor chemical antiseptics in the commonly known forms is attempted, but instead,

there is introduced what Baer calls a viable antiseptic.

Following a battle in 1917, during the World War, Baer observed two soldiers who had sustained compound fractures of the femur, and large flesh wounds of the abdomen and scrotum. They had been lost on the battlefield for 7 days, without water, food, or medical attention. To his great surprise, their condition, save for that incidental to hunger and thirst, was remarkably good. Closer inspection revealed that their wounds, which presented pink granulations, practically no bare bone, and only a few streptococci and staphylococci, were filled with thousands of maggots.

For ten years, Dr. Baer thought of this experience, and finally in 1927, he put his observations to practical use in civil surgery. The story of Baer's struggles with, and the surmounting of the problems which arose incidental to obtaining a continuous supply of sterile maggots, and their application to surgical problems, is stranger than fiction. His experiments to show that the maggots can successfully contend with any infecting organism, save tetanus, are masterful. The meticulous technique he developed for the culture of the fly larvæ and their clinical application has been recently published, posthumously, in great detail, and will therefore not be gone into at this time.

We had the good fortune to visit Dr. Baer at his Clinic in the winter of 1930, and were so impressed with his results that on the basis of our report, the Medical Board of the Hospital for Joint Diseases set aside twelve beds and all the necessary laboratory facilities to investigate this treatment. Although our investigation has not been carried on for a sufficient length of time to enable us to render a final report, we feel justified in making known our experiences and observations.

¹Read before the Orthopedic Section, New York Academy of Medicine, December 18, 1931.

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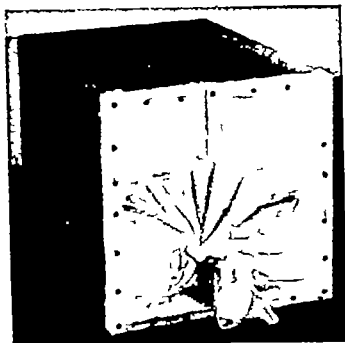


Fig 2 Fly cage covered on five sides with fine wire mesh while the front is covered with scrim fitted with a sleeve for convenient entry. The size of the cage is such as to fill an entire compartment of the incubator

keep these pads well moistened. Besides the honey, yeast, and water mixture, thin folded slices of beef about 2 inches square are placed in the cages. The beef serves as an essential source of food, for Roubaud has shown experimentally that in the absence of nitrogenous substances, the production of eggs does not occur and the flies remain sterile, although their lives are not shortened. Furthermore, he has shown that chemotropism plays a part in egg-laying for which the stimulus is best supplied by meat. These foods are placed in the cages as soon as the flies begin to hatch.

After about 7 to 10 days, egg laying begins. The eggs are deposited in the folds and on the dark under sides of the meat. The meat with the eggs may then be stored in the ice box at 40 degrees F for as long as 24 hours, or sterilization may be carried out at once. At any rate, one should wait several hours before sterilizing the eggs, for the hatches from eggs that are sterilized immediately after laying are not as large as from those in which there has been a delay of several hours. The eggs are carefully picked from the meat with a wooden applicator, placed in a small amount of cold water and the clumps of eggs are gently broken up.

The apparatus (Fig 3) for the sterilization and washing of the eggs is prepared as follows. Gooch crucibles are lined with pieces of muslin covering the perforated plates and extending half way up the sides. The crucibles are covered wrapped and sterilized in hot air at 160 degrees C for 1 hour. For the steriliza-



Fig 3 Apparatus for sterilization of eggs consisting of a Gooch crucible lined with a piece of muslin covering the perforated plate and extending half way up the sides, fitted into a filter tube which is suspended by a triangle over a tripod. The lower end of the filter tube is fitted with rubber tubing which can be clamped by a pinch-cock. A waste beaker is placed for the filtrate.

tion process, the crucibles are fitted into filter tubes which are always kept in 5 per cent phenol solution. These are held suspended by means of triangles over tripods with beakers underneath to catch the filtrate. The narrow lower ends of the filter tubes fit into pieces of rubber tubing which can be clamped by means of pinch-cocks. When this apparatus has been set up, about 1,000 eggs are poured into each Gooch crucible. The water is allowed to pass through and the rubber tube is closed by means of the pinch-cock. The crucible is then completely filled with the sterilizing fluid, its surface is flamed, and the crucible is covered. The eggs are sterilized for one-half hour in this solution which contains 1:4,000 bichloride of mercury, 25 per cent alcohol, and 0.3 per cent hydrochloric acid. At the end of the allotted time, the sterilizing solution is drained into a waste beaker and the eggs are washed with about 5 ounces of sterile water. The muslin with the eggs on its surface is then transferred with sterile forceps from the crucible to an Erlenmeyer flask containing sterile food.

The sterile food consists of 10 per cent Bacto-liver and 15 per cent of agar in distilled water. Two and a half cubic centimeters are measured into each Erlenmeyer flask, which is plugged with a muslin-covered cotton

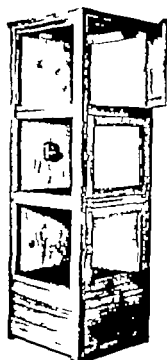


Fig. Incubator partitioned horizontally by perforated sheets of galvanized iron. Under the lowermost compartment is section in which electric space heaters are installed to maintain the temperature at 75 to 80 degrees F. On the back wall of the middle compartment is the thermostat. In the roof of the incubator are vents to which motor driven blower is connected by pipes for ventilation. Pans of water are placed on the top of the electric space heaters to maintain the humidity at 50 per cent.

TECHNIQUE OF THE CULTURE OF MAGGOTS

The first problem was to culture the maggot of the blowfly. Notwithstanding Baer's detailed technique, a great many difficulties were encountered, for slight variations in temperature, humidity, ventilation, and feeding resulted in decimation of the flies and the sterilization of the eggs was a problem in itself. As a result of our studies, we have evolved our own technique, which is based on that of Baer's and its modification by Edward F. Roberts.¹

We utilize for the breeding of flies a wooden incubator (Fig. 1) with glass sides and doors, measuring 24 inches wide, 38 inches deep by

75 inches high. It is divided horizontally into three sections by perforated sheets of galvanized iron. Under the lowermost section there is a compartment in which there are installed thermostatically controlled electric space heaters, which maintain a temperature of 75 to 80 degrees F. Pans of water are placed on the top of the electric heater to insure a humidity of about 50 per cent. Ventilation is maintained by a motor driven blower connected by several vents to the top of the incubator. The blower is so arranged that it draws out of the incubator air which enters by way of two holes, one on each side of the base and leaves through the vents in the top. By plugging one or more of these vents the degree of ventilation may be controlled. Electric bulbs on the outside of the incubator supply the necessary light.

After several months' trial, we abandoned the use of the small cages devised by Dr. Baer for housing flies. These were replaced by larger cages (Fig. 2) consisting of wooden frames, 20 by 25 by 18 inches, covered on five sides with fine wire mesh. The front of the cage is covered with scrim fitted with a sleeve to enable convenient entry. The larger cages are very satisfactory as a time-saving device in the feeding and handling of the flies. Furthermore, the life of the flies and their fecundity is increased.

Our experience with these cages confirms the observations of Roubaud, who has shown that in larger cages, longevity is increased and egg lays are more numerous. He has noticed that in small cages wings break readily thus interfering with flight and resulting in lessening of metabolism. It also appears that the activity incidental to flight aids in the abdominal contractions necessary for the deposition of eggs.

The flies are fed on a mixture of strained honey and water in the proportion of 6 tea spoonfuls of honey to 300 cubic centimeters of tap water. To this is added about one-fifth of a cake of yeast. Medium thick pads of gauze are thoroughly soaked with this mixture and placed in petri dishes in the bottom of the cages. This mixture is renewed about twice a week. On the other days, sufficient water is added to the petri dishes to

¹ Dr. Roberts was in charge of the culturing of maggots at the Lederle Laboratories at Port Jervis, New York. His own work was very kind in co-operating with us, and we gratefully acknowledge our appreciation of his help.



Fig 5

Fig 5 Case 1 An extensive osteomyelitic involvement of the right tibia and fibula and left tibia.

Fig 6 Case 1 The right tibia 7 months, the right fibula 5½ months, and the left tibia 2½ months after the operation and the beginning of maggot therapy. Note the homogeneous bone repair.

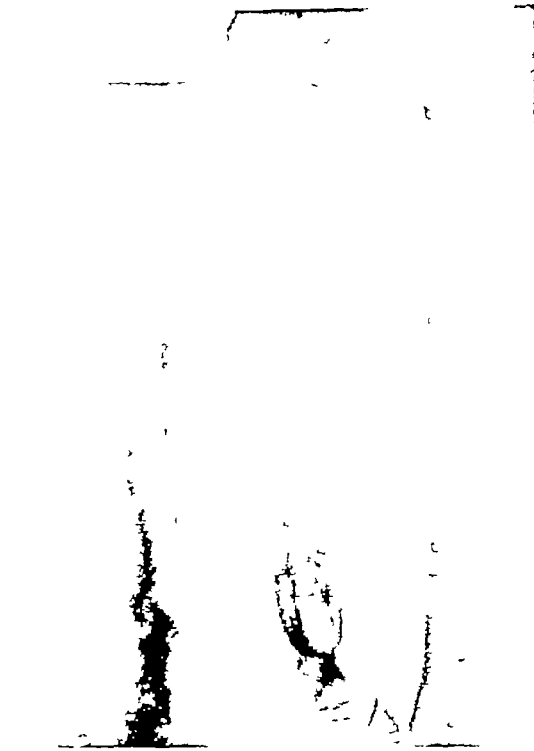


Fig 6

Fig 7 Case 1 An extensive osteomyelitic process of the right humerus.

Fig 8 Case 1 The humerus 3½ months after operation and the beginning of maggot therapy. Note the absence of areas of sclerosis and rarefaction seen in other methods of treatment.

affected by this parasite. Furthermore, the physiological variations are very great (Roubaud). Even under constant conditions of temperature and alimentation, the succession of egg lays is irregular in numbers and periods. The latter may vary in intervals from 3 days to several weeks. It is, therefore, not surprising that even with the best of care the supply of maggots will be interrupted from time to time especially during the winter and humid seasons.

To overcome these difficulties it is advisable to accumulate a large quantity of pupæ for such contingencies. The Bureau of Entomology of the United States Department of Agriculture has proved experimentally that the pre-pupa maggot, that is, the 5 to 7 day old maggot, and the pupa can be kept inactive

at 40 degrees F for several months at least, possibly longer. We have fortified ourselves against such contingencies by accumulating a large number of pupæ which are kept in the ice-box. This is especially necessary in large cities where the blowfly is hard to find.

The *Phormia regina*, *Sucilla sericata*, and the *Lucilia caesar* are the species of flies which were found satisfactory by Baer. This was confirmed by our experience. Care must be taken, however, to guard against unknown species. We had one unfortunate experience resulting from the accidental introduction of an unknown species. In an effort to increase our stock of flies, meat was exposed in a local butcher shop in which a great number of green and blue bottle flies were seen. For the same reason maggots were taken from a fac-



Fig. 4. Left, wound before the application of the cage; right, muslin cage held in place by liquid adhesive.

plug and the flask and contents are sterilized in an autoclave for 15 to 20 minutes at 15 pounds pressure. The medium is smooth and homogeneous and the 2.5 cubic centimeters are sufficient to feed the maggots for 3 days. Out of each batch of flasks prepared one is controlled for sterility while the rest are stored in the ice box, where they will keep for a month.

After inserting the eggs into the Erlenmeyer flask, they are incubated in the dark at 75 to 80 degrees F. Hatching begins in about 8 to 24 hours. The day after the eggs are sterilized and hatched control cultures are made in both Bacto-brain-heart infusion (aerobic) and Bacto-egg meat medium (anaerobic). The transplants for these cultures consist of a small piece of medium with one or two maggots. The cultures are incubated for 48 hours. Thus, at the end of 48 to 72 hours from hatching the sterility of the maggots is assured and they are ready for use. The larvae may be used immediately or if necessary they may be stored in the ice box at 40 degrees F. for several days. This period of storage does not shorten their period of usefulness for they become inactive and require no food.

In addition to raising maggots for treatment purposes, it is necessary to grow a sufficient number of larvae to maintain a breeding stock of flies. Our experience has been that if 25 to 100 eggs are left on the meat from which eggs have been removed for sterilization purposes, and are allowed to hatch, there will be enough maggots to maintain the supply of flies. The pieces of meat with the remaining eggs are therefore put into wide mouthed 2 ounce bottles, covered with muslin and allowed to hatch. After 5 days, the covers are

removed from the bottles, and the latter are then placed into muslin covered large beakers, in the bottom of which there is about 1½ inches of ground cork. In about 7 days, when the maggots are ready to pupate, they crawl over the sides of the bottles, dig their way into the cork, and pupate. The pupating beakers should be kept in a dark incubator at 75 to 80 degrees F. When all the larvae have left the breeding bottles, the bottles are removed. In 5 to 8 days, when the flies are ready to emerge from their pupal cases, the beakers are placed in the breeding cages.

It will be seen from the technique described that a great deal of labor and time is saved over the previously described methods of breeding.

In general the breeding of maggots, simple as it seems is confronted with many failures and disappointments. These are due to an insufficient knowledge of the life history, physiology and pathology of the fly. According to Wollman the difficulties in the culture of flies are due to injuries and intercurrent infections. Under the heading of injuries, wing breakage is most important. Its effects have already been discussed in relation to the construction of cages. The chief intercurrent infection is that due to the parasite known as *Empusa muscae*. It appears to be very common among flies. Its action however is slow and the longevity and fecundity of the host is not affected to any great extent under favorable conditions. Sudden climatic changes, however especially a sudden lowering of the temperature or an increase of humidity will hasten its pathological activity and cause very extensive mortalities (Roubaud). Fortunately our stock has apparently not been



Fig 13



Fig 14.



Fig 15

Fig 13 Case 4. Roentgenogram taken immediately after first operation

Fig 14 Case 4 Three months later, showing smooth and evenly calcified bony repair of upper half of saucerized area while the lower half shows sequestra and irregularities in calcification

Fig 15 Case 4 Five months after the second operation and further maggot therapy Note the smooth bony repair

of the vaseline gauze About 1,000 maggots are then introduced into the wound and a cage is applied

Baer's method of transferring the maggots to the wound involved the removal of the maggots from their food medium, their suspension in saline solution, the passing of this through a sterile spoon with a perforated bottom, and the emptying of this spoon containing the maggots into the wound This is a rather fussy procedure resulting in the loss of very small maggots which may pass through the holes of the spoon and the crushing of others in the process of handling We have simplified this by adding saline solution to the Erlenmeyer flask containing the maggots and passing this suspension through a piece of fine meshed sterile muslin The muslin containing the larvæ is then placed into the depth of the wound This method has proved to be much simpler, faster, and less wasteful

It was originally our practice to use cages of the type devised by Dr Baer Their preparation was tedious and time consuming Furthermore, they were irritating to the skin about the wound clumsy in application, and on occasions inefficient in that maggots es-

caped from time to time We, therefore, looked about for a simpler and less time consuming method It occurred to us to paint the edges of the wound with liquid adhesive and to spread over the skin and wound a piece of sterilized fine meshed muslin This simple method (Fig 4) proved very effective, and has been used exclusively ever since

Since the life of the maggot is only 7 days 2 of which elapse in the process of growing to a sufficient size and culturing for bacteria only 5 days are left for their utilization in the actual treatment of wounds It is, therefore, necessary to change these dressings every 5 days at the utmost until the wound is completely filled with granulations

Baer advised thorough washing of the wound with saline at each of these dressings This we have found unnecessary, and on a theoretical basis inadvisable We feel that if maggots produce enzymes or bring forth favorable substances on the part of the host, meticulous removal of these substances does not appear rational or desirable We merely mop the wound clean with gauze and remove the remains of the dead maggots, thus saving a great deal of time and effort



Fig. 2, left. Case 2. An area of rarefaction surrounded by an area of irregular sclerosis in the suprascapular and intercondylar regions.

Fig. 2, right. Case 2. Four months after operation and maggot therapy showing homogeneous bone repair. The area of rarefaction is still discernible.

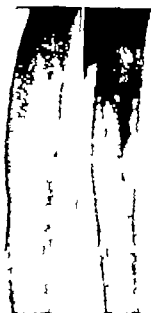


Fig. 3, left. Case 3. A chronic sclerosing osteomyelitis of the femur with irregular bone formation.

Fig. 3, right. Case 3. Two months after the onset of treatment. Note the reformation of normal bony structure without the irregularities of calcification present previously.

tory in which chicken feathers were used for commercial purposes. The resulting maggots and pupae were indistinguishable from those of the known species with which they were inadvertently mixed. When the next batches of sterile maggots were introduced into osteomyelitic wounds, we were shocked to find deleterious effects, for these maggots had bored large cavities in the healthy granulations and had actually increased the size of the wounds, which were angry looking and caused considerable pain. Needless to say the entire batch of flies, maggots and pupae was discarded. A number of these flies was submitted to a competent entomologist for classification. Unfortunately he was unable to recognize the offending fly because only specimens of the male species had been submitted, while his key apparently depended upon the female. The United States Department of Agriculture in its *Farmers Bulletin No 857* describes the screw worm maggot and in a personal communication warned against its use.

CLINICAL PHASE OF THE MAGGOT TREATMENT

The clinical phase of this treatment vies with its laboratory counterpart in that its

problems are intricate and time consuming. We must emphasize, as did Dr. Baer that this is a surgical problem which cannot be passed over lightly. The preparation of the part consists of shaving and cleansing with soap and water. No chemical disinfectants are used. The operative procedure must be a complete and thorough saucerization. All devitalized bone must be removed for reasons that will be discussed later. Because of the extensiveness of the operation it should be done whenever possible under tourniquet control. It is our practice to line the saucerized wound liberally with vaseline gauze, pack its center with plain gauze, and subsequently apply a compression bandage of sheet wadding flannel bandage and adhesive plaster. Plaster-of-Paris bandage support is used when fracture of the part is feared. It is also used to eliminate pain and discomfort when the operative wound is extensive and in close proximity to a joint. After 3 or 4 days, the packing is removed—a procedure which is comparatively painless and bloodless because

may be sufficient for a well and thoroughly saucerized area. On the other hand, in an adult who has had a long standing condition, many operations, and a brawny limb with lymphatic changes, a considerably greater number of dressings and a proportionately longer period of time are necessary for the filling in of the wound.

The latter type of case is at times complicated in our experience by sudden rises of temperature to 104 or 105 degrees F within 24 to 48 hours of the introduction of the maggots. In several of these cases the limbs presented an erysipeloid appearance, with bullæ formation. The general condition, however, remained good and after about 48 hours the temperature, local heat, swelling, and tenderness subsided. These reactions are apparently due to the opening of chronically infected lymphatics by the action of the maggots. At any rate, this complication, although at first alarming, is apparently of no great consequence. In the first few instances, we removed the maggots from the wounds, but, on subsequent occasions, the treatment was not interrupted. Warm wet dressings of magnesium sulphate eased local condition greatly.

Throughout the treatment, the general condition of the patient is good, the temperature, pulse, and respiration range about the normal level. There is little or no discomfort save that incidental to occasional sharp twinges of pain resulting from the incessantly active and crawling maggots when they strike sensitive spots. These twinges may be sufficient at times to keep the patients, especially adults, awake at night and may necessitate the use of sedatives. Several times, we were compelled to remove the maggots temporarily.

We have been impressed, as was Dr. Baer, with the character of the healing that occurs under the influence of maggots. As previously noted, the wounds present a type of healthy granulation tissue which is rarely seen under other conditions. The soft tissues about the wound remain soft and non-adherent to the bone. In several cases which necessitated secondary operation, we were strongly impressed with the lack of scarring and the macroscopically normal appearance of both the recently deposited bone and soft tissue.

We, as well as our roentgenographer, Dr. Pomeranz, have noted that roentgenographically the newly deposited bone is characteristic and different from that noted in other methods of treatment. New bone formation in these cases is smoothly and evenly calcified and does not present the blotchy appearance seen in other types of healing of osteomyelitis.

As previously stated, our experience with this method has not extended over a sufficiently long period of time to enable us to give a statistical study to show either the number of treatments or the length of time necessary to heal wounds, or the frequency of recurrences. We are favorably impressed, however, with the very satisfactory character of the healing processes, the rapidity with which these take place, the lack of extensive scarring, the improvement of the general well-being of the patient, and the lack of untoward incidents in the great majority of cases. All of this, however, is dependent upon a very thorough and radical removal and saucerization of the involved parts. Under this system of therapy we have never noted any excoriation or the least irritation of the surrounding parts, even though we studiously avoided any form of protection. The maggot therapy does not necessitate the minute, caretaking, time and effort consuming technique involved in the dakinization of wounds. The maggot treatment is furthermore more appealing than the Orr technique in that healing takes place more rapidly, gives better scars, and does not routinely necessitate prolonged periods of immobilization in plaster of Paris, nor is it characterized by any offensive odor. However, the period of hospitalization may be longer than with the Orr method, which allows temporary discharge from the hospital during the intervals of dressings. If the consideration of expense is a factor, the method under discussion is more expensive than either the Dakin or Orr treatment, for the expense involved in culturing or buying maggots from commercial houses is considerable.

CASE REPORTS

We cite the following cases as examples of the efficiency of the use of maggots in chronic osteomyelitis.



Fig. 6



Fig. 7

Fig. 6 Case 5. A 47 year old white female sustained a fracture of the right tibia and fibula on December 3, 1929. Because of malposition and delayed union an open operation was performed and an ivory peg was inserted. Osteomyelitis developed. A sequestration operation and Orr treatment was instituted on August 14, 1930. The condition progressed very poorly and amputation was considered before the patient came under observation. On January 9, 33, sequestration operation was performed and maggot therapy was instituted. Roentgenograms show condition before last operation.

Fig. 7 Case 5. After 5 maggot dressings. The patient was discharged after a period of 3 months from the date of operation with the wound healed save for a small area lacking epithelium. This picture was taken 3 months after that shown in Figure 6. Note character of repair: reformation of cortex, lack of irregularities in calcification and approximation of appearance toward the normal.

The subsequent progress of the wound is very surprising indeed. Within one to several days the acid reaction becomes alkaline. The bacterial count diminishes rapidly. Any odor that may be present is cleared up. Purulent and irritating discharges disappear and are replaced by a very abundant, serous, non-irritating discharge which must be continuously drained off lest the maggots be drowned. Within several days, the aspect of the wound changes completely. Under the cover of a thin and easily removable dirty gray pellicle, fine, pink, and firm granulations appear rapidly and begin to fill the wound from the bottom up. After a variable number of such dressings, depending upon factors to be discussed later the wound becomes ob-

literated. The resulting scar is soft and only infrequently adherent or depressed. In those instances in which the dressings are not changed at about the time of the death of the maggots, the wound becomes filled with a thick, purulent odoriferous discharge which is easily eliminated by the introduction of a new batch of maggots.

The number of dressings necessary to fill a wound completely varies with the age of the patient, the size of the wound, the extent of scarring of the part due to chronicity, previous operations, and lymphatic changes, and above all upon an uninterrupted course of maggot dressings. In children whose limbs are not scarred or extensively indurated by the chronicity of the process, six or seven dressings

Six days after the operation, the packing was removed and maggots were introduced. The patient had six maggot dressings in all, and on October 6, 1931, was discharged from the hospital with a small granulating wound. Two weeks later, that is, 10 weeks after the operation, the wound was completely healed. More recent examination revealed that the wound had remained healed, that there was practically no depression, and very little adherence of the scar to the underlying bone. The range of motion about the knee extended from 180 degrees of extension to 90 degrees of flexion. Roentgenographic studies showed evenly calcified new bone (Fig 10).

The rapidity with which this wound filled without any sinus formation is worthy of note because when one is operating in a bone near a joint, one usually contents himself with an incomplete saucerization for fear of entering the joint. Yet, in this case, despite the incomplete saucerization, the wound filled up rapidly and thoroughly without sinus formation. This fortunate result is we believe possible through the maggot therapy.

CASE 3. A K., a 13 year old white male, was admitted to the hospital because of a persistent sinus following an acute exacerbation of a chronic osteomyelitis 1 month previously. Five years ago, he sustained a fracture of his left femur which was treated with a Lane plate because of the failure of closed methods of reduction. He apparently had an uneventful convalescence until 2 years later, when an abscess developed at the site of the operation. This was accompanied by pain, tenderness, redness, and swelling. The abscess was incised and drained. One month later, he underwent an operation for the removal of a loose Lane plate, as demonstrated by an X-ray film. The plate and three screws were removed, but the fourth screw could not be found. The wound healed in 8 weeks. Eighteen months later, a sinus appeared, and the following month, the fourth screw was removed by an operation. A sinus persisted, however, for 8 months. After healing, it remained so for 7 months, when it recurred, and persisted for 1 month, at which time the patient came under our observation.

Examination at this time was negative save for the local condition, namely, a scar on the outer aspect of the left thigh, with two discharging sinuses. A roentgen-ray study (Fig 11) revealed an area of marked sclerosis with irregular bone formation at the junction of the middle and upper third of the femur.

On January 16, 1931, a 6 inch area was saucerized and a culture revealed that the offending organism was a staphylococcus aureus. Eight days later, maggots were introduced into the wound. After two additional maggot dressings, the character of

the wound was so excellent that it was allowed to collapse. One month after the operation, the wound was entirely healed, save for a small area lacking epithelium. Several weeks later, the wound was entirely healed and has remained so to date. The scar is soft and non-adherent. An X-ray study showed a satisfactory new bone formation (Fig 12).

CASE 4. W. C., a 34 year old white male, was admitted to the hospital because of a persistent chronic osteomyelitis of the left femur of 27 months' duration. In November, 1928, the patient sustained a compound fracture of his left femur as the result of a train accident. Following this, he was treated at 5 different hospitals by surgical staffs who were very adept at the methods they applied, namely, debridement, the Orr treatment, Beck's paste, and a repetition of the Orr and the Dakin methods. During this period he had ten major operations, including a periarthral sympathectomy of the femoral artery, and he was bedridden during this entire interval.

Examination at this time showed a suppurating wound on the inner and lower aspect of the left thigh, a healed scar on the opposite side and a healed scar in Scarpa's triangle. The knee was ankylosed at 150 degrees. The lower half of the thigh and the upper half of the leg were indurated and brawny. A roentgen-ray study revealed a chronic osteomyelitic process involving the lower third of the shaft of the femur with a large excavated area in the medulla in the supracondylar region. This was surrounded by irregularly sclerosed bone. Numerous sequestra were present. The knee was completely ankylosed, and the patella was fused to the femur.

On February 6, 1931, a saucerization operation was performed through an antero-internal approach, the old scar and the entire front of the femur being removed. The bone was found to be sclerosed. The patella and the knee joint were not disturbed. Figure 13 shows the postoperative X-ray appearance of the femur.

Three days later, maggots were introduced. Forty-eight hours later, the patient had a chill, the entire extremity became swollen, red, and presented an erysipeloid appearance. This was accompanied by a rise of temperature to 105 degrees. The maggots were immediately removed and warm magnesium sulphate dressings were applied locally. In 3 days, the systemic condition subsided, and 2 days later, the swelling disappeared. Maggots were again introduced at this time. This was followed by five additional dressings with maggots over a period of 6 weeks, at which time a reaction similar to that described recurred, 3 days after the last dressing. This time the temperature rose to 106 degrees. The maggot dressings were left undisturbed and, after several days, the condition subsided.

The appearance of the wound at this time was somewhat puzzling. The upper half was progressing and healing rapidly and satisfactorily, while the lower half presented a large cavity behind the patella. X-ray examination (Fig 14) showed that the upper

CASE 1: A H., a 10 year old white male, complained on admission to the hospital of pain, deformity and inability to use his lower limbs, and of discharging sinuses of both legs, of 9 months' duration. The onset was characterized by high fever, pain, and swelling of the right leg. Two weeks thereafter two sinuses appeared with a profuse discharge of pus. A few weeks later the left leg was similarly involved with like consequences, and after several months, pain appeared in his right arm subsiding again in a few weeks.

Examination revealed that the patient was in a very poor general condition, underweight, undernourished, and totally disabled. He presented marked flexion adduction deformities of both hips with a great loss of motion at these joints. There were flexion deformities, partial subluxation, and limitation of motion of both knees. The feet were in marked equinus and immobile. There were in addition, discharging sinuses in both legs and several healed bed sores over the sacrum, back, and about the greater trochanters. Roentgenographic examination showed an extensive osteomyelitis involving both tibiae, the right fibula, and a destructive arthritis of the right knee joint.

In view of the poor general condition the patient was given supportive measures and after a month's care, he improved considerably. Because the extent of the involvement of both tibiae was similar (Fig. 5) it was decided to treat the left limb by the Orr method and the right limb by the maggot technique. A saucerization and Orr dressing were therefore performed on the left tibia on March 20, 1931. On April 3, 1931, a similar procedure was carried out on the right tibia, but the Orr dressing was omitted. After a period of 6 weeks, during which four maggot dressings were applied, the wound was entirely healed save for a very small area which was slowly being epithelialized. On June 24, 1931, the right fibula was saucerized, and after a period of 3 months during which eight maggot dressings were applied, this wound also healed save for a small area lacking epithelium. At the end of 9 weeks, this wound was completely healed. On the left side, the control side, a number of Orr dressings were performed but after a period of 6½ months, a discharging sinus persisted.

A comparison of both limbs at this time showed that on the side treated with maggots, both operative wounds (one after 7 weeks, and the other after 9 weeks) were perfectly healed, the scars were excellent, and have remained so to date. Further more, the wounds had filled up to the level of the surrounding tissues. On the control side, there was a persistent sinus after 6½ months of treatment, and the scar was considerably depressed. Comparative X-ray studies showed that the limb treated with maggots presented an evenly calcified bone scar of excellent texture and appearance, while on the control side, the bone deposition was irregular with areas of sclerosis, rarefaction, and evidence of remaining osteomyelitic activity.

It was, therefore, decided to re-operate upon the control side and institute the maggot treatment. On October 2, 1931, the left tibia was explored and saucerized. Operation revealed several areas of granulation tissue and a perforation of the posterior cortex which was not found at the previous operation. Since the second operation, eleven maggot dressings have been applied and the wound is now completely healed after a period of 10 weeks. X-ray examination (Fig. 6) revealed satisfactory healing. The bone regeneration was homogeneous, smoothly and evenly calcified.

During the course of these events, a slabs appeared over the right humerus and a roentgenographic study (Fig. 7) revealed an extensive chronic osteomyelitic process with sequestrum formation. This area was saucerized on September 4, 1931, and the maggot treatment was instituted. Fifteen maggot dressings were applied, and now, after a period of 14 weeks, the wound is practically healed. X-ray examination (Fig. 8) at this time also shows a homogeneously calcified bony regeneration.

The case presented an unusual opportunity for comparison of the Orr and the maggot techniques under ideal conditions. The results are so contrasting that we are left with the impression that the maggot treatment in this individual was more effective from the point of view of rapidity and character of the healing processes.

CASE 2: A P., a 35 year old white male gave a history of an acute osteomyelitis of the lower end of the femur 27 years ago, subsequent to an injury he sustained with a knife in that region. Thereafter he had a severe attack, characterized by severe pain and disability. This subsided without operative interference. Eight years ago he had a similar attack.

Three weeks previous to his admission to the hospital the knee became swollen, painful, and disabling. Physical examination on August 3, 1931, showed a flexion deformity of the knee, extension being limited at 60 degrees, and flexion at 120 degrees. Motion between these extremes was painless. There was tenderness along the line of articulation and more so over the lower end of the femur. Examination of the X-rays (Fig. 9) showed an area of rarefaction in the supracondylar and later condylar regions of the femur. This was surrounded by an area of irregular sclerosis.

On August 7, 1931, a saucerization operation was performed through a lateral approach without entering the knee joint. Two abscess cavities were encountered, one about 2 1/4 of an inch in diameter containing seropurulent material and another 3/4 of an inch in diameter containing thick yellow pus. The latter cavity had perforated into the popliteal space. A culture taken from the wound showed a staphylococcus aureus hemolyticus infection.

Six days after the operation, the packing was removed and maggots were introduced. The patient had six maggot dressings in all, and on October 6, 1931, was discharged from the hospital with a small granulating wound. Two weeks later, that is, 10 weeks after the operation, the wound was completely healed. More recent examination revealed that the wound had remained healed, that there was practically no depression, and very little adherence of the scar to the underlying bone. The range of motion about the knee extended from 180 degrees of extension to 90 degrees of flexion. Roentgenographic studies showed evenly calcified new bone (Fig 10).

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The appearance of the wound at this time was somewhat puzzling. The upper half was progressing and healing rapidly and satisfactorily while the lower half presented a large cavity behind the patella. X-ray examination (Fig 14) showed that the upper

portion of the area operated upon had healed satisfactorily and that the new bone was homogeneous in character while the lower half of this region presented alternating patches of sclerosis and rarefaction with sequestra formation.

The patient was, therefore, subjected on May 18 to a second operation which was more radical than the preceding one. The entire patella, save for its anterior covering, and the anterior portion of both femoral condyles were removed. The entire area was then thoroughly sequestrized.

During the following 7 weeks, nine maggot dressings were used, and 1 month later that is 11 weeks after the second operation, the patient was discharged to a convalescent home, walking for the first time in 33 months. The wound was healed save for a superficial area which was slowly but satisfactorily epithelializing. When the patient was seen 1 month later the wound was completely healed and has remained so to date. Roentgenographic studies (Fig. 15) at this time showed smooth bone regeneration throughout the area operated upon. No irregular patches of sclerosis or rarefaction were to be seen. The patella had reformed.

The case demonstrates the rapidity with which repair can take place under the influence of maggot therapy provided the operative procedure is thorough. When one considers the resistance and the chronicity of the case, despite the previous excellent care, one cannot but be favorably impressed with the effect of the maggot treatment.

THEORETICAL CONSIDERATIONS

The rationale of the maggot treatment is less well understood than its laboratory or clinical aspects. The action of the maggot and how it is carried out are still unanswered questions. Dr. Baer believed that the maggot acts primarily as a scavenger and secondarily it induces the secretion of substances by the host which are favorable for the healing processes.

A review of the scanty entomological and experimental literature on this subject reveals some very enlightening information. Wollman states that the conformation of the buccal cavity and that of the upper alimentary tract of the maggot are such as to permit the consumption of liquid foods only. Furthermore it has been noted that cadavers on which blow fly larvae subsist undergo rapid liquefaction. This was also shown experimentally by Fabre who planted maggots in tubes of coagulated

white of egg, tubes of meat, and tubes of gelatin. In each of these instances rapid liquefaction occurred and these liquids contained the end-products of proteolytic activity. Fabre, therefore, concluded that maggots produce proteolytic enzymes which act on the proteins and break them down into their end products upon which the maggot thrives.

Guyenot made numerous extracts of whole maggots, of their salivary tracts, and of their digestive tracts but was unable to demonstrate any enzymes. He, therefore, concluded that maggots do not produce enzymes, but depend for their food upon the action of proteolytic bacteria which they spread as they bore through the tissues they infest. His conclusion with reference to the production of enzymes is incorrect, for liquefaction occurs when sterile media and sterile maggots are used. However if meat or egg yolk be sterilized at very high temperatures of 120 degrees F or over thus precluding proteolytic activity sterile maggots will not thrive. If micro-organisms, proteolytic or otherwise, be introduced into this medium, maggots will thrive. It is, therefore, evident that maggots will subsist on the products of the proteolytic activity of their own enzymes, the products of the activity of proteolytic micro-organisms or on the micro-organisms themselves, proteolytic or otherwise.

Clinical observations support these conclusions. As noted in the clinical section of this communication, the introduction of maggots into a wound produces rapidly a considerable amount of fluid substances. Furthermore, the bacterial content of the wound rapidly diminishes.

Our clinical observations lead us to believe that the proteolytic activity and the physical removal of micro-organisms by the maggot are not the only factors in this healing process. If a maggot be placed on the palm of the hand and its tail be held firmly a tickling or scratching sensation will be experienced as the maggot tries to get away from the restraining finger. Clinically the sensations of crawling and twinges of pain experienced by the patient are indicative of physical irritation. At times when the maggots are excessively active the wound and surrounding parts present redness

and tenderness and local heat indicative of irritation. Furthermore, when maggots are introduced into wounds toward the end of the treatment when the wounds are very clean, and the maggots become short-lived, the effect is nevertheless a rapid increase in granulations and filling up of the wound. All of these observations lead us to believe that the irritation incidental to the physical presence and milling about of the maggots is sufficiently minimal to stimulate the tissues to growth. This belief is strengthened by our observation that healing is more rapid in children than in adults, and in parts that are least scarred and have least secondary lymphatic changes than in those that have had numerous operations, or have undergone long periods of chronic inflammation, that is, younger and healthier tissues respond more readily to stimulation.

Another important question that has to be answered if the maggot treatment is to be accepted is whether or not there is a systemic reaction. And if so, is it deleterious or not? We cannot as yet answer the question fully, for our experiments are still in progress. Up to the present time, our observations lead us to believe that there is no systemic reaction save that mentioned previously, namely, the sudden rises in temperature noted in some of our cases. Daily blood studies have shown only an occasional and unrelated rise in the eosinophile count.

In view of the fact that it has been demonstrated in infestations with intestinal and cutaneous parasites that cutaneous hypersensitiveness to these organisms frequently develops, it seemed of interest to determine whether a similar hypersensitiveness results in patients under treatment with maggots. Intracutaneous skin tests were therefore performed with sterile extracts prepared from maggots and flies. A slightly positive immediate cutaneous reaction appeared in 5 of 12 patients under maggot treatment for periods ranging between 1 to 6 months. This cutaneous sensitivity seems to be based upon the circulating type of antibody, the reagin, which is the one usually responsible for these reactions in protein hypersensitiveness and in parasitic infestation. This conclusion is justified because passive local sensitization of

normal skins with the serum of some of these patients has been accomplished by the technique of Prausnitz and Kuestner. However, the slight degree of sensitivity, induced by maggots in only some of these patients is of no clinical significance, in so far as can be determined from our present investigations in this small series of cases. Further studies along these lines are being made.

The failure to react to the presence of the maggots may therefore be taken as presumptive evidence that the maggot therapy had no deleterious effect upon the human system. The converse is also true, that is, the human system does not produce substances harmful to the maggot. At first sight, it appeared that this was not so, for it had been noted that after a number of treatments in a given wound the maggots became short-lived. Further study led to the belief that the shortening of the life span of the larvæ was due merely to a gradual diminution of sustenance as the wound cleared up and became smaller. This was demonstrated in one of our cases with two wounds at different stages of healing. In these the life span of the maggots was different, longer in the more recent lesion, and shorter in the older wound. From this we deduce that the longevity of the maggot depends upon local and not systemic conditions. In addition, we have noted that the wound secretions present at the time of death of the maggots are harmless to newly introduced larvæ. One may, therefore, conclude that the relationship of the maggot to the human system in the treatment of suppurative wounds does not give rise to harmful effects upon either one or the other.

And now we come to another question, which, in view of all the work done, may sound rather facetious. Do maggots eat, destroy, or remove dead bone? Our answer is no, they do not. Experiments performed *in vitro* with bone, be it either dead in the form of sequestra or living at the time of removal from the body, show that maggots will remove about one-half of the bone by weight, leaving a framework of honeycombed bone intact. Clinically, it has been our experience that devitalized bone is not removed by the maggots. This naturally leads us to the admonition that

the operative procedure must be thorough and complete otherwise sinus formations will occur necessitating secondary operations.

SUMMARY

In closing we wish to present our impressions of the maggot treatment of osteomyelitis. They are studiously tempered with conservatism to overbalance the enthusiasm of the investigators in their study of something new and very promising. On the whole notwithstanding the great deal of work, trials and expense incidental to this method, we are of the belief that the maggot therapy is safe, efficient and productive of good results—results at times so rapid and excellent as to overshadow all other methods available to us. One need but watch the daily change in the appearance of the wound, its gradual obliteration without the extensive scarring noted in other methods and the comparative comfort of the patient, to realize that the maggots are instituting a superior process of healing. We feel however that before this treatment becomes general, further study and experimentation is necessary to elucidate many problems and questions that arise, and to insure a continuous supply of maggots—a very difficult problem—upon the success of which will depend the popularity, applicability and success of the treatment.

This work has been made possible by the beneficence of the management of the Hospital for Joint Diseases under the leadership of Dr. J. J. Golub, to whom we are grateful for his patience and encouragement. We are thankful to Drs. Samuel Kleberg and Henry L. Jaffe for their advice and support. We also wish to express our gratitude to Dr. Julius Kretzma for his unstinted assistance in the care and handling of the clinical and operative material, to Dr. Matthew Walker for his experiments in hypodermic

inoculation, and to Miss Silks Stecker and Miss Frances Hallman for their untiring work in the culture of the maggots—the backbone of the treatment.

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AVERTIN IN GYNECOLOGY

A REPORT OF THREE HUNDRED CONSECUTIVE CASES

REUBEN PETERSON, M D, F A C S, ANN ARBOR, MICHIGAN

AND

JAMES M PIERCE, M D F A C S, CINCINNATI, OHIO

From the Department of Obstetrics and Gynecology of the University of Michigan

SINCE ether was introduced in 1846, there has been a constant search for the ideal anæsthetic, which (1) should induce anæsthesia as gently and naturally as sleep itself, (2) should not irritate in its administration or elimination, (3) should make the awakening of the patient as natural as from a deep sleep, without nausea, headache, or intestinal paralysis, and lastly, (4) should produce sufficient relaxation for the performance of the operation desired without the operator fighting the abdominal muscles or the intestinal coils

With this ideal in mind, Halstead introduced local anæsthesia, and Corning spinal anæsthesia in 1885. These two types of anæsthesia have been improved and developed to the point where they occupy a very important place in surgery. Later nitrous oxide, ethyl chloride, ethylene, and sodium amytal were introduced, but these are not ideal anæsthetics.

In 1847, Pirogoff first advocated rectal anæsthesia. This method of administration has never been popular, Gwathmey's ether in oil being possibly an exception. In 1923, Duesberg and Willstaetter prepared tribomethanol for rectal administration. In 1925, Butzengeiger presented this anæsthetic before the Berlin Surgical Society, but it was not until 1927 that Eichholtz demonstrated its true anæsthetic properties. Since that time at least 250,000 cases have been reported in the literature of Germany, England, and the United States.

Chemically the drug is tribromomethyl alcohol and is commercially known as avertin. The pharmacological actions have been studied by Eichholtz, Straub and later by Bruger, Bourne, and Dryer, of Montreal. They have shown that the drug is absorbed very rapidly from the rectum and that it is eliminated by the kidneys in combination with glycuronic acid. It is estimated that 80 per cent of the drug is absorbed

in the first 20 minutes and that it has no ill effect upon the bowel. When first used, there were cases of severe irritation of the bowel and even gangrene, but this was due to the fact that in preparing the drug it was heated to too high a temperature, the drug was broken up and the irritation caused by the dibromacetoldehyde eliminated. Bruger, Bourne and Dryer have shown that avertin has very little action upon liver function and causes only a slight kidney depression, that the blood bicarbonate is very little affected, that the hydrogen-ion concentration of the blood is increased, and that there is a definite fall in body temperature.

At the present time we are prepared to report our observations in 300 consecutive cases, as shown in the accompanying Table I.

In this series of 300 cases, 186 patients or 62 per cent received avertin only, 110 patients or 36.66 per cent avertin plus nitrous oxide, and only 4 patients, or 1.33 per cent, avertin plus ether.

There were 172 laparotomies in which in 58.14 per cent avertin only was given, 39.54 per cent avertin plus nitrous oxide, and 2.32 per cent avertin plus ether.

In 128 vaginal operations, avertin only was administered in 67.18 per cent and in 32.81 per cent avertin plus nitrous oxide.

Carbon dioxide was given slowly in 25 cases to stimulate the respiratory center, caffeine sodium benzoate in 47 cases, and ephedrine in 25 cases.

In the anæsthetic charts 1 to 5 which accompany this article, the action of these stimulants may be noted.

In all of the cases the same methods of preparation and administration have been used. The evening before operation, a cleansing enema was given, and 10 grains of chloretone. The morning before operation, no enema was given but 10 grains of chloretone were given at 6 a.m. One-half hour before the ad-

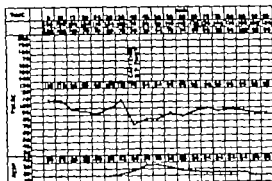


Chart 1. Anesthesia chart showing response to caffeine sodium benzoate after supravaginal hysterectomy and bilateral salpingo-oophorectomy for fibroma of the uterus and bilateral salpingo-oophoritis. Patient weighed 16 pounds. Before anesthetic was given patient received $\frac{1}{4}$ grain of morphine and $\frac{1}{100}$ grain atropine during the anesthetic at 0.35 a m. ampel of caffeine sodium benzoate. The avertin was administered as follows: 268 cubic centimeters of 3 per cent solution, rate, 10 milligrams per kilogram. The administration of the anesthetic was begun at 0.35, patient was sleeping at 10:00, operation was begun at 10:30, ended 11:15. Patient was returned to bed at 11:17, anesthetic left patient at 11:30. Pulse was 92, respiration, 20. Patient's condition was fair before, during, and after operation.

ministration of avertin $\frac{1}{4}$ grain of morphine and $\frac{1}{100}$ grain of atropine were given.

No enema is given before the administration of the avertin because it might not be completely expelled, and there would result a slow absorption of the drug or an inability to retain the drug when administered. Avertin without the previous administration of morphine has been given a trial but it has been found that the induction is smoother and relaxation much better when the morphine is given. It has not been observed that cyanosis or respiratory depression is increased by its use. The morphine may be omitted in some patients, but should be used in all nervous and hypersensitive people. It is believed the chloroform is valuable in giving the patient a good rest during the night preceding the operation and that its use before the administration of the avertin aids the morphine in securing a smooth quiet induction.

At first the drug was used in crystalline form and considerable care was necessary in making up the correct solution. Avertin fluid is now employed 1 cubic centimeter containing 1 gram of the drug. The dose is calculated according to the patient's weight, age and

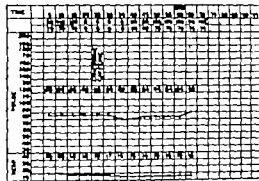


Chart 2. Anesthesia chart showing fall in blood pressure and response to epinephrine and caffeine sodium benzoate in operation for prolapsed uterus, cystocele, and rectocele. Operation consisted of amputation of cervix, hysteropexy, perineorrhaphy. Patient weighed 35 pounds. Before anesthetic was administered $\frac{1}{4}$ grain morphine and $\frac{1}{100}$ grain atropine were given during anesthetic 1 cubic centimeter of epinephrine and 1 ampel of caffeine sodium benzoate. The avertin was given as follows: 254 cubic centimeters at the rate of 10 milligrams per kilogram. The administration of the anesthetic was begun at 10:00, patient was sleeping at 0.4, operation was begun at 0:45, ended at 1:05. Patient was returned to bed at 1:30. Anesthetic left patient at 1:30. Pulse was 90, respiration, 16. Patient was in fair condition before, during, and after operation.

general health. Sufficient distilled water is added to make a 3 per cent solution and the solution is administered as a retention enema. According to weight the dose varies from 80 to 110 milligrams per kilogram of body weight. With regard to age it has been found that children tolerate it better than adults and the aged much less than the middle aged. Alcoholics, hypersensitive individuals, and those with acute abdominal conditions need a larger dose while the adipose and the feeble need much less. In general those who are hard to anesthetize by any method need larger doses than the emaciated feeble and poor risks. An average dose of 100 milligrams per kilogram has been used and never more than 110 milligrams per kilogram.

It has been noted that the avertin causes a fall in blood pressure varying from 20 to 50 milligrams of mercury that the jaw drops and that the cough reflex is absent. The absence of this reflex contra indicates the use of the drug in tuberculosis and bronchiectasis. There may be some cyanosis and the respirations may become shallow. However neither the fall in blood pressure nor the respiratory

TABLE I.—SUMMARY OF CASES

No of cases	Type of operation	Avertin only	Avertin plus N-O	Avertin plus ether	CO ₂	Stimulants necessary	
						Caffeine sodium benzoate	Ephedrine
31	Panhysterectomy + single salpingo-oophorectomy or bilateral salpingo-oophorectomy	21	9	1	12	10	2
58	Subtotal hysterectomy + single salpingo-oophorectomy or bilateral salpingo-oophorectomy	32	25	1	10	12	8
95	Plastic	68	27	0	3	17	9
34	Sterilization (abdominal)	19	15	0	0	2	0
31	Salpingo-oophorectomy	15	16	0	0	2	5
6	Shortening of round ligaments	6	0	0	0	1	0
4	Exploratory laparotomy	3	1	0	0	0	0
3	Radical panhysterectomy	1	0	2	0	0	0
4	Laparohysterotomy and sterilization	2	2	0	0	0	0
2	Colpotomy	1	1	0	0	0	0
15	Vaginal hysterectomy	9	6	0	0	3	1
11	Vaginal sterilization	5	6	0	0	0	0
1	Vaginal oophorectomy	0	1	0	0	0	0
1	Abdominal drainage	1	0	0	0	0	0
2	Therapeutic abortion	1	1	0	0	0	0
1	Ureteral transplant	1	0	0	0	0	0
1	Excision of Bartholin cyst	1	0	0	0	0	0
300	Total	186	110	4	25	47	25
300	Percentage	62	36.66	1.33	8.33	15.66	8.33
172	Laparotomies Cases Per cent	100 58.14	68 39.54	4 2.32	22 12.81	27 15.69	15 8.72
128	Vaginal operations Cases Per cent	86 67.18	42 32.81	0 0	3 2.41	20 15.62	10 7.81

Maximum dose of avertin 110 milligrams per kilogram of body weight.

Minimum dose of avertin 90 milligrams per kilogram of body weight.

Average fall in systolic blood pressure in 300 cases 37 millimeters mercury.

Average fall in diastolic blood pressure in 300 cases 20.74 millimeters mercury.

Average increase in respiratory rate in 300 cases 10.3 per minute.

Postoperative complications due to anæsthetic: rectal irritation none; liver damage none; pneumonia none.

Deaths none.

depression should cause any alarm, for the blood pressure may be elevated rapidly by giving 1 to 2 cubic centimeters of ephedrine and the respiratory center stimulated with caffeine sodium benzoate. When the drug was first used the two stimulants were employed frequently but with the administration of the proper dose, it is rare that any is given, since only occasionally does cyanosis or drop in blood pressure follow.

The drug is administered in the patient's room by the anæsthetist and attending nurse. The patient is not told that the enema is the

anæsthetic, but that the enema is necessary before the operation. The blood pressure is taken and the enema given slowly. Within 3 to 5 minutes the patient is in a deep sleep and can be taken to the operating room and prepared for the operation. There should be no hurry for it has been found that the patient is better anæsthetized if 20 to 30 minutes elapse between the administration and the beginning of the operation.

Throughout the operation the anæsthetist takes the blood pressure every 5 minutes and keeps the throat open by means of an airway.

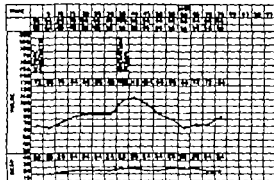


Chart 3. Anesthesia chart in vaginal sterilization operation after court order. Avertin only was used, no stimulants. Note the slight increase in respiratory rate and the small blood pressure changes. The blood pressure was taken every 5 minutes. One-fourth grain of morphine and $\frac{1}{160}$ grain of atropine were given before the anesthesia was started. Patient weighed 135 pounds. The avertin was given as follows: 5 cubic centimeters 3 per cent solution, at the rate of 1.0 milligram per kilogram. The administration of the anesthetic was begun at 8:55 patient was sleeping at 9:05. Operation was begun at 9:30, ended at 9:40. Patient was returned to bed at 9:15. Anesthetist left patient at 10:15. Pulse, 84, respiration, 24. Patient was in fair condition before, during, and after operation.

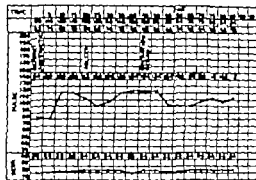


Chart 4. Anesthesia chart during vaginal hysterectomy for persistent metrorrhagia and chronic catarrhal cervicitis with cystic degeneration. Patient weighed 116 pounds. Before the anesthetic was given, patient was given, at 7:00 a.m., $\frac{1}{2}$ grain of chloroform and at 8:30 a.m. $\frac{1}{2}$ grain of morphine and $\frac{1}{160}$ grain of atropine. The avertin was given as follows: 5 cubic centimeters of 3 per cent solution, at the rate of 1.0 milligram per kilogram. The administration of the anesthetic was begun 1:00, patient was sleeping at 9:05. Operation was begun 1:30, ended at 10:15. Patient was returned to bed at 10:15. Anesthetist left patient at 11:40. Pulse was 112, respiration, 24. Patient was in good condition before operation, in fair condition during anesthesia and after.

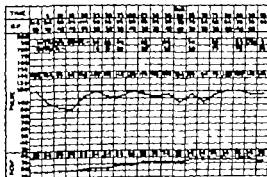


Chart 5. Anesthesia chart made in case of bilateral salpingo-oophorectomy. The chart shows the result of the use of nitrous oxide gas to produce sufficient relaxation. Operation was done in a patient suffering with chronic bilateral salpingitis, tubo-ovarian abscess, right, cystic ovary left. Before the anesthetic was administered, patient was given $\frac{1}{4}$ grain morphine, $\frac{1}{160}$ grain atropine, and after the anesthetic 700 cubic centimeters of normal salt infusion. Patient weighed 174 $\frac{1}{2}$ pounds. The anesthetic was given as follows: avertin and nitrous oxide gas—85 cubic centimeters, 3 per cent, at the rate of 1.0 milligram per kilogram. The administration of the anesthetic was begun at 8:34, patient was sleeping at 9:01. Operation was begun at 9:37, and was completed at 10:31. Patient was returned to bed at 10:35. Anesthetist left patient at 10:40. Pulse was 116, respiration, 20. The patient's condition was good before the operation, fair during the administration of the anesthetic and fair after the anesthesia.

The respirations are slow and shallow as in deep sleep and if there is any cyanosis an ampul of caffeine sodium benzoate is given. If the blood pressure drops rapidly 1 to 2 cubic centimeters of epinephrine are given. The blood pressure usually becomes stationary or rises as soon as the operation is begun.

If there is insufficient relaxation, nitrous oxide and oxygen are given in the proportion of .5 per cent nitrous oxide and 25 per cent oxygen. In only 4 cases has ether been necessary. These were radical panhysterectomies for cancer of the cervix, and difficult hysterotomies. With this small amount of nitrous oxide there is as much relaxation as under deep ether anesthesia. The respirations are shallow and there is no fighting with intestinal coils pushing into the operative field whether the operation is an abdominal or vaginal hysterectomy. In fact in many cases a pack is not necessary to keep the bowel coils out of the field but is used only to prevent trauma to them.

This anesthesia lasts for $1\frac{1}{2}$ to 3 hours. Then the patient usually falls into a normal sleep that may last 8 to 10 hours. Many of the patients operated upon at 9 a.m. awoken

at midnight and ask when their operation is going to be done. There is little postoperative nausea or vomiting. There is a complete amnesia lasting from the time of administration until the patient is fully awake. There are very few gas pains. Since avertin has been used the patients have very few, if any, gas pains except in those cases in which the bowel is traumatized in separating adhesions. Because there is little postoperative nausea and vomiting and very few gas pains, the patient's convalescence is more comfortable and rapid.

CONCLUSIONS

Avertin more nearly approaches the ideal anæsthetic than any other drug which has been employed in the clinic, because it—

- 1 Induces a deep sleep very smoothly,
- 2 Causes very little postoperative nausea and vomiting,
- 3 Produces a complete amnesia,
- 4 Fewer gas pains follow its administration,
- 5 It irritates none of the body organs either in the process of its administration or in its elimination.

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INDICATIONS FOR AND TECHNIQUE OF ILEOSTOMY IN CHRONIC ULCERATIVE COLITIS

J. ARNOLD BARGEN M.D. PHILIP W. BROWN M.D. ROCHESTER, MINNESOTA
Division of Medicine

AND

FRED W. RANKIN M.D. F.A.C.S., ROCHESTER, MINNESOTA
Division of Surgery The Mayo Clinic

VARIOUS forms of medical treatment of chronic ulcerative colitis have apparently yielded encouraging results. Crohn and Rosenberg reported favorably on irrigations with acriflavin. Burnford was enthusiastic about ionization. Haskell and Cantarow expressed the belief that systemic treatment with para thor moone and calcium is highly beneficial. These and many other methods of treatment, totally at variance in general principle, suggest a groping for specific treatment. Favorable reports have been issued on the use of some form of immunizing agent. Soper, Fradkin and Gray, Streicher and Kaplan, Lynch, Portis, Rouse, Kracke, Surmont and Buttiaux, Muniz, Chisholm, Debenedetti, Horgan and Horgan, Borgen, and Rosenow and Fasting represent only a small number of those who have reported good results with the use of vaccine prepared from the diplostreptococcus so commonly found in ulcers in these cases. We have reported further good results with the use of the specific antibody solution (concentrated serum).

In an effort to evaluate the present status of ileostomy for chronic ulcerative colitis, we have reviewed the 82 cases in which this operation was performed at The Mayo Clinic in the decade 1921 to 1930, inclusive (Table I). The ages of the patients varied from 7 to 61 years. One patient was in the first decade of life, 4 patients were in the second decade, 22 in the third, 32 in the fourth, 17 in the fifth, 5 in the sixth, and 1 in the seventh. Fifty-two patients were males, and 30 were females.

Twenty-six patients were farmers, 12 were housewives (about equally divided between city and country), 6 were clerks, 6 were school children (3 girls and 3 boys), 5 were merchants, 2 were lawyers, 2 were engineers, 2 were mechanics, 3 were teachers, 2 were laborers, 2 were restaurant owners, 2 were

carpenters, and 1 each was a bridge foreman, bank cashier, railroad agent, railroad fireman, insurance agent, manufacturer, druggist, chauffeur, painter, dental technician, draftsman and 1 without occupation.

Eleven of the patients came from Minnesota: 7 from South Dakota, 7 from Iowa, 6 from Illinois, 5 each from Wisconsin, Michigan, Montana, and Indiana, 4 from New York, 3 each from Kansas, North Dakota, and Colorado, 2 each from Texas, Missouri, Mississippi, Oklahoma, and Saskatchewan and 1 each from Ohio, Alabama, Nebraska, Wyoming, Virginia, Alberta, Manitoba, and Mexico.

One patient had been ill for 1 month, 5 patients for 2 months, 4 from 4 to 6 months, 4 from 6 to 8 months, 1 patient from 8 to 10 months, 1 from 10 to 12 months, 10 patients from 1 to 1½ years, 2 from 1½ to 2 years, 13 from 2 to 3 years, 6 from 3 to 4 years, 11 from 4 to 5 years, 4 from 6 to 7 years, 4 from 7 to 8 years, 3 from 9 to 10 years, 4 from 10 to 11 years, 1 patient for 12 years, 1 for 14 years, 1 for 17 years, 2 patients for 19 years, 3 for 20 years and 1 patient for 25 years.

The time elapsing between a patient's first admission to the clinic and ileostomy is of interest for it suggests the trend in therapeutic methods. Forty-one patients were operated upon less than a month after their first admission; their disease, in the main, was long standing, complicated or severe. Twelve patients were operated on less than 2 months after their first admission, 5 less than 3 months, 1 patient less than 6 months, 2 patients less than 8 months, and 2 less than 10 months. Two patients were operated on 1½ years after their first admission, 4 2 years, 3 3 years, 1 patient, 4 years, 4 patients, 5 years, 2 7 years and 1 patient 8 years.

The various treatments used preliminary to ileostomy have been listed by years.

TABLE I—DATA ACCORDING TO YEARS

	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	Total
New patients	49	46	57	63	102	134	154	189	197	202	1193
Ileostomies	6	9	16	13	8	12	3	5	8	2	82
Deaths among patients not operated on	5	4	7	6	6	9	4	4	6	6	57

In 1921, treatment ranged from none to irrigations with hot water, local treatment with bismuth and olive oil, chinisol and witch hazel, in one case appendicostomy was performed, and in one tonsillectomy.

In 1922, treatment included hypodermic injections of emetin hydrochloride (this was given in one case as a therapeutic test for amoebic colitis), transfusion, irrigations with hot water, local treatment with witch hazel, cautery to ulcers, tincture of iodine, and bismuth and opium powders by mouth.

In 1923, treatment included emetin hydrochloride, transfusions, tincture of iodine by mouth, irrigations of the colon with hot water, argyrol, silver nitrate, boracic acid, and instillations of olive oil. Treatment prior to the patient's registration at the clinic sometimes included milk diet, Battle Creek diets, osteopathic treatments, and hospitalization in sanitariums for the treatment of tuberculosis.

In 1924, treatment included tincture of iodine, kaolin, bismuth, iron, paregoric by mouth, irrigations with hot water, local treatment with witch hazel, intravenous injections of gentian violet, and transfusions.

In 1925, one patient received vaccine filtrate, two patients received vaccine, others were given local treatment with witch hazel, one patient had infected teeth removed, and one received calcium by mouth and para-thor-mone.

In 1926, treatment included vaccine filtrate and vaccine, para-thor-mone and emetin hypodermically, iodine, paregoric, kaolin, calcium, and stovarsol by mouth. Tonsillectomy was done in one case, irrigations with physiologic sodium chloride solution in one, and argyrol in one. In two cases the whole serum was given for the first time.

In 1927, treatment included vaccine, serum, transfusions and mercurochrome and gentian violet by mouth.

TABLE II—SURGICAL INDICATIONS AND MORTALITY ACCORDING TO GROUPS

		Cases	Mortality	
			Early	Late
Group 1	First fulminating attack and progressive failure	9	5	1
Group 2	Chronic, with acute exacerbation and progressive failure	21	8	1
Group 3	Chronic, with acute exacerbation and acute complications as polyarthritides, stomatitis, erythema nodosum, and perirectal infection	8	5	2
Group 4	Chronic, not responding to medical treatment	28	7	9
Group 5	Chronic with complications as polyposis, stricture, incontinent anus, carcinoma	13	1	2
Group 6	Chronic, with diagnostic difficulties. Mass in left side of abdomen. Lesion in right half of colon (tuberculosis or chronic ulcerative colitis). Lesion in right half of colon (tuberculosis or chronic ulcerative colitis).	3		
Total		82	26	15

In 1928, treatment in the clinic included vaccine and serum, irrigations with acriflavine in 1 case, intravenous injection of neoarsphenamine in 1 case, and ileosigmoidostomy in 1 case elsewhere.

In 1929, treatment included vaccine, specific antibody solution (concentrated serum), emetin, and para-thor-mone hypodermically, removal of infected tonsils and teeth, stovarsol, iodine, bismuth and calcium by mouth.

In 1930, treatment included specific antibody solution (concentrated serum), and insulin to create appetite in 1 case.

The 82 cases will be divided into six groups according to types (Table II).

The causes of death were divided into early and late, the former referring to deaths in hospital before the patients left the clinic after the ileostomy, and the latter to deaths that occurred several months after the patients returned home. In the early group there were 26 (30 per cent), in the late group, 15 (19.5 per cent). Replies were not received from 12 patients to whom letters were sent. The latest information concerning the other 29 living patients was received in January, 1931.

The causes of death of the 26 patients who died early were as follows: general peritonitis 14, inanition and dehydration, 4, hæmor-

TABLE III.—KNOWN RESULTS IN SEVENTY CASES (JANUARY 1931)¹

Group	Cases	Mortality	Late results		
			Cured	Fair	Poor
Group	9	4			4
Group 1	8				
Group 4	44	7			9
Group 5			7		
Group 6					
Total	82		77		7

¹Twelve of the operations were not successful, but previous labor pains had not been satisfactory concerning and the 5 others were in fair condition.

rhage 2 and 1 each from abscess in the abdominal wall postoperative per-ileostomy infection and exhaustion pulmonary embolism carcinomatosis, and myocardial infarction. The causes of deaths that occurred at home or at the clinic on a second visit included peritonitis after attempted closure of the ileostomy opening, plastic operation on ileostomy intestinal obstruction abscess in the abdomen, multiple fistulas, pneumonia, endocarditis, leukemia and inanition.

The fact that 52 of the patients were males may in itself not be significant, but in our experience it is more difficult to convince women than men of the desirability or necessity of ileostomy.

The age incidence corresponds closely with the incidence of greatest occurrence of the disease. Most patients were in the third, fourth and fifth decades of life. In recent years we have seen more cases in children but have performed few ileostomies in these cases because surgical complications were rarely present.

The occupations represent the average duties of life but it is noteworthy that none of the patients operated on was a physician yet each year we have seen a fair number of physicians with the disease.

In the early years (1921 to 1925) when the condition did not respond to irrigation with medicated solutions and other accepted therapeutic measures, ileostomy was done. In 1926 because of the better results from medical treatment there was a sudden increase in

the number of cases observed, including many in which the disease was advanced. In recent years we have learned that the response to treatment with vaccine and serum is often rather slow and therefore ileostomy should not be done until therapeutic measures have been given months of systematic trial. This is borne out by the fact that in 1930, the year the greatest number of cases of chronic ulcerative colitis were observed at the clinic, the smallest number of ileostomies was performed. The long interval between the first admission and ileostomy in the early cases was due to the fact that many patients who did not respond to conventional treatment went home, and when the disease progressed and complications developed, they returned for ileostomy.

With regard to preliminary treatment, it is sufficient to say that by present methods the disease of fully 75 per cent of these patients coming to the clinic is controlled. Streicher recently stated that complete relief of symptoms was obtained by medical treatment in 84 of the 107 cases (approximately 80 per cent) and Gray gave similar figures following the subcutaneous administration of vaccine.

The causes of unsatisfactory progress after ileostomy follow closely the type of case. Many of the 29 patients known to be alive in January 1931 were not satisfied with the results of ileostomy others were wholly unable to earn a living and were reduced to a state of chronic invalidism (Table III).

In 10 cases of group 4 the patients reported 6 to 9 years later that rectal discharges of blood streaked purulent material persisted as before operation. Six patients from group 2 reported 2 to 8 years later that their trouble continued as before and that they were unable to carry on their occupations. Two patients from group 1 reported 1 and 6 years later that their trouble continued. The one patient of group 3 reported 7 years after operation that he was 50 per cent better.

It is exceedingly difficult to evaluate these results as each case has been an individual problem. We cannot state that ileostomy might better have been postponed or even not attempted since we are convinced that it has saved some lives. It is in the acute phase of the disease that the question of operation is

debatable In groups 1, 2, and 3 (Table II), in which cases of the acute phases of the disease were classified, there are 38 cases, and the early operative deaths were 18 (47 per cent) Of the 20 patients who survived the immediate operation, 16 are still living but the condition of 8 of them has not improved We believe that in these particular groups our present medical regimen offers more than surgical treatment, besides sparing the patient the annoyance of ileostomy Undoubtedly an occasional case will be an exception The discouraging results in 33 of the 38 cases (the 18 operative deaths and the 4 later deaths) certainly make us feel that operative treatment should be undertaken only after the most intensive and thorough medical treatment

In group 4 (Table II), the chronic cases, in which surgical treatment was selected after discouraging trial with medical treatment, it is logical that poor results would occur The patients had been depleted by disease for months, usually years, and changes in the heart, liver, and kidneys existed in addition to severe infection of the walls of the colon The immediate mortality was 25 per cent, about half that in the acute cases Nine patients (32 per cent) died later, and 10 of the surviving patients are chronic invalids (Table II) One patient reported that he was in good condition, and another, although still having trouble, was able to work most of the time From the study of these four groups (Table II), it is difficult to escape any conclusion other than that uncomplicated chronic ulcerative colitis is primarily a medical disease and only in rare instances is surgery advisable

The question of deciding whether to close the ileostomy opening or to perform ileosigmoidostomy is also difficult Closure was safely effected in 1 case, 1 year after ileostomy, but 2 years later the patient suffered an acute exacerbation of the disease which was treated medically

Incidentally it may be noted that appendicostomy had been performed in 2 cases and caecostomy in 1 case prior to admission, the operation had been of little, if any, value In 1 case colostomy, in the lower part of the

descending colon had been done, and later ileostomy was done

Ileosigmoidostomy had been performed in 2 cases, in 1 case at the clinic and in 1 elsewhere The latter patient had become discouraged by medical treatment at the clinic and went elsewhere for the operation Following this, he became much worse, the stools increased from 8 to 10 daily to 20 and 25 He returned to the clinic, when ileostomy seemed the only possible procedure, especially after another short trial of medical treatment The operation was performed and death resulted from peritonitis In 1 case ileostomy had been done a year previously The condition seemed quiescent but following ileosigmoidostomy, peritonitis and death resulted In the third case, ileostomy and subtotal colectomy had been done and ileosigmoidostomy was finally undertaken The patient survived the operation but died 5 months later from an acute exacerbation of the colitis, undoubtedly the onset was in the rectum with rapid extension into the ileum We feel that after ileostomy has once been established, it must be considered permanent We also feel that the present type of treatment may finally control the disease and make it possible to institute surgical procedures in the form of ileostomy, since caecostomy and ileosigmoidostomy yield so little in the way of relief

Ten patients are known to be in good health and are satisfied with ileostomy, because of striking relief from the trouble for which the ileostomy was performed Seven of these operations were performed for complications of chronic ulcerative colitis (group 5, Table II), including polyposis, stricture, perirectal abscess, and absence of anal sphincter, the result of fistulectomy elsewhere Five other patients reported that they were doing fairly well and were able to work, but that rectal discharges of blood and pus continued Naturally the mortality is low as the disease is not acute nor is the patient so likely to be depleted We have no recent data on 4 cases of this group The 3 other patients known to be well were of groups 2 and 4, and one would be justified in assuming that ileostomy had not only saved their lives but had made it possible for them to go on as useful citizens

TABLE III.—KNOWN RESULTS IN SEVENTY CASES (JANUARY 1931)¹

Group	Cases	Mortality	Late results		
			Good	Fair	Poor
Group 1	9	6			
Group 2	11	9			6
Group 3	8	7			
Group 4	16	17			9
Group 5	3		7		
Group 6	3				
Total	50	47	26		7

¹Twelve of the questionnaires were not answered, but previous later patients had not been satisfactory concerning 7 and the 5 others were in fair condition.

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debatable In groups 1, 2, and 3 (Table II), in which cases of the acute phases of the disease were classified, there are 38 cases, and the early operative deaths were 18 (47 per cent) Of the 20 patients who survived the immediate operation, 16 are still living but the condition of 8 of them has not improved We believe that in these particular groups our present medical regimen offers more than surgical treatment, besides sparing the patient the annoyance of ileostomy Undoubtedly an occasional case will be an exception The discouraging results in 33 of the 38 cases (the 18 operative deaths and the 4 later deaths) certainly make us feel that operative treatment should be undertaken only after the most intensive and thorough medical treatment

In group 4 (Table II), the chronic cases, in which surgical treatment was selected after discouraging trial with medical treatment, it is logical that poor results would occur The patients had been depleted by disease for months, usually years, and changes in the heart, liver, and kidneys existed in addition to severe infection of the walls of the colon The immediate mortality was 25 per cent, about half that in the acute cases Nine patients (32 per cent) died later, and 10 of the surviving patients are chronic invalids (Table II) One patient reported that he was in good condition, and another, although still having trouble, was able to work most of the time From the study of these four groups (Table II), it is difficult to escape any conclusion other than that uncomplicated chronic ulcerative colitis is primarily a medical disease and only in rare instances is surgery advisable

The question of deciding whether to close the ileostomy opening or to perform ileosigmoidostomy is also difficult Closure was safely effected in 1 case, 1 year after ileostomy, but 2 years later the patient suffered an acute exacerbation of the disease which was treated medically

Incidentally it may be noted that appendicostomy had been performed in 2 cases and cæcostomy in 1 case prior to admission, the operation had been of little, if any, value In 1 case colostomy, in the lower part of the

descending colon had been done, and later ileostomy was done

Ileosigmoidostomy had been performed in 2 cases, in 1 case at the clinic and in 1 elsewhere The latter patient had become discouraged by medical treatment at the clinic and went elsewhere for the operation Following this, he became much worse, the stools increased from 8 to 10 daily to 20 and 25 He returned to the clinic, when ileostomy seemed the only possible procedure, especially after another short trial of medical treatment The operation was performed and death resulted from peritonitis In 1 case ileostomy had been done a year previously The condition seemed quiescent but following ileosigmoidostomy, peritonitis and death resulted In the third case, ileostomy and subtotal colectomy had been done and ileosigmoidostomy was finally undertaken The patient survived the operation but died 5 months later from an acute exacerbation of the colitis, undoubtedly the onset was in the rectum with rapid extension into the ileum We feel that after ileostomy has once been established, it must be considered permanent We also feel that the present type of treatment may finally control the disease and make it possible to institute surgical procedures in the form of ileostomy, since cæcostomy and ileosigmoidostomy yield so little in the way of relief

Ten patients are known to be in good health and are satisfied with ileostomy, because of striking relief from the trouble for which the ileostomy was performed Seven of these operations were performed for complications of chronic ulcerative colitis (group 5, Table II), including polyposis, stricture, perirectal abscess, and absence of anal sphincter, the result of fistulectomy elsewhere Five other patients reported that they were doing fairly well and were able to work, but that rectal discharges of blood and pus continued Naturally the mortality is low as the disease is not acute nor is the patient so likely to be depleted We have no recent data on 4 cases of this group The 3 other patients known to be well were of groups 2 and 4, and one would be justified in assuming that ileostomy had not only saved their lives but had made it possible for them to go on as useful citizens

TABLE III.—KNOWN RESULTS IN SEVENTY CASES (JANUARY 1931)¹

	Cases	Mortality	Late results		
			Good	Fair	Poor
Group	9	6			
Group		9			6
Group 3	8	7			
Group	25	17			
Group 5	3		7		
Group 6	3				
Total	55	41			7

¹ Twelve of the questionnaires were not answered, but previous information had not been satisfactory concerning 7 and the 5 others were in fair condition.

riuge 2 and 1 each from abscess in the abdominal wall postoperative peri-ileostomy infection and exhaustion pulmonary embolism, carcinomatous and myocardial infarction. The causes of deaths that occurred at home or at the clinic on a second visit included peritonitis after attempted closure of the ileostomy opening plastic operation on ileostomy intestinal obstruction abscess in the abdomen multiple fistulas, pneumonia, endocarditis, leukemia and inanition.

The fact that 52 of the patients were males, may in itself not be significant but in our experience it is more difficult to convince women than men of the desirability or necessity of ileostomy.

The age incidence corresponds closely with the incidence of greatest occurrence of the disease. Most patients were in the third, fourth and fifth decades of life. In recent years we have seen more cases in children but have performed few ileostomies in these cases because surgical complications were rarely present.

The occupations represent the average duties of life, but it is noteworthy that none of the patients operated on was a physician yet each year we have seen a fair number of physicians with the disease.

In the early years (1921 to 1925) when the condition did not respond to irrigation with medicated solutions and other accepted therapeutic measures, ileostomy was done. In 1926 because of the better results from medical treatment there was a sudden increase in

the number of cases observed including many in which the disease was advanced. In recent years we have learned that the response to treatment with vaccine and serum is often rather slow and therefore ileostomy should not be done until therapeutic measures have been given months of systematic trial. This is borne out by the fact that in 1930, the year the greatest number of cases of chronic ulcerative colitis were observed at the clinic, the smallest number of ileostomies was performed. The long interval between the first admission and ileostomy in the early cases was due to the fact that many patients who did not respond to conventional treatment went home, and when the disease progressed and complications developed, they returned for ileostomy.

With regard to preliminary treatment, it is sufficient to say that by present methods the disease of fully 75 per cent of these patients coming to the clinic is controlled. Streicher recently stated that complete relief of symptoms was obtained by medical treatment in 84 of the 102 cases (approximately 80 per cent) and Gray gave similar figures following the subcutaneous administration of vaccine.

The causes of unsatisfactory progress after ileostomy follow closely the type of case. Many of the 29 patients known to be alive in January 1931 were not satisfied with the results of ileostomy others were wholly unable to earn a living and were reduced to a state of chronic invalidism (Table III).

In 10 cases of group 4 the patients reported 6 to 9 years later that rectal discharges of blood streaked purulent material persisted as before operation. Six patients from group 3 reported 2 to 8 years later that their trouble continued as before and that they were unable to carry on their occupations. Two patients from group 1 reported 1 and 6 years later that their trouble continued. The one patient of group 3 reported 7 years after operation that he was 50 per cent better.

It is exceedingly difficult to evaluate these results as each case has been an individual problem. We cannot state that ileostomy might better have been postponed or even not attempted since we are convinced that it has saved some lives. It is in the acute phase of the disease that the question of operation is

barreled ileostomy instead of double barreled. Since the former method of irrigating the colon has fallen into disrepute, the cæcal end of the ileostomy is useless and, protruding alongside the proximal loop, makes an abdominal anus more difficult to take care of. Furthermore, should one desire to resect the colon subsequently, because of any of the indications mentioned, the single barreled ileostomy is a decided help in that it lessens the difficulties of the operative technique and permits one to proceed with the subsequent removal of the large bowel without having to consider so much of an infected field. The type of ileostomy we are describing has been used in 6 cases, as a preliminary step to resection of the colon. Three of the operations were done for chronic ulcerative colitis and 3 for multiple polyposis. The very decided advantages which this type of ileostomy gives the patients, so far as its care is concerned, have inclined us to continue the procedure. There is a disadvantage to a single barreled ileostomy which will be voiced immediately in the event a stricture develops along the course of the colon due to the chronic ulcerative colitis, it leaves a blind loop of bowel full of pus and detritus without an opportunity for drainage. This, however, is of infrequent occurrence, and moreover it is highly probable that the majority of patients with chronic ulcerative colitis who submit to operation will be subjected sooner or later to partial or total exeresis of the colon.

The technique of this ileostomy is relatively simple. A point midway between the umbilicus and the anterosuperior spine on the right side is selected and a split muscle incision is made. The diagnosis is always established by roentgenograms and proctoscopic examination, and it is not necessary to explore the colon. Indeed any exploration of the colon however carefully done is likely to result in disaster, since even by the gentlest manipulation one may inadvertently thrust the examining finger into the diseased cæcal wall. A point in the ileum, about 12 or 14 centimeters from the ileocæcal valve, is selected and the blood supply to this portion of the bowel is divided between clamps, and ligated, the bowel is then severed between clamps

with a cautery. The end nearest the cæcum is inverted with any type of inverting stitch and is dropped back into the abdomen. Between the mesentery of the proximal end of the bowel and the lateral parietal peritoneum a number of stitches or a single running stitch obliterates the raw space, just as would be done in making a colostomy in the sigmoid on the opposite side. This prevents obstruction by small loops of bowel which might slip behind the ileostomy. In case there is a wide space with small chance of obstruction this step would be unnecessary. The proximal end with clamp on it, is brought out through the incision and sutured to the peritoneum by interrupted silk sutures. The wound is closed tight with catgut sutures and a clamp is strapped to the abdomen and allowed to remain unopened for 48 hours. By strict adherence to a regimen of total abstinence of fluids by mouth, and maintenance of the fluid balance by intravenous and subcutaneous injections of glucose and salt solutions these patients are carried through the first few days following the operation with slight discomfort and without any evidence of obstruction. When the clamp is taken off the end of the bowel is teased open and a small catheter is thrust into the loop for drainage.

Usually the immediate convalescence is complicated by considerable loss of fluid and drastic efforts to maintain a satisfactory water balance are necessary. As time goes on and the ileum gradually takes on cæcal function and the stools become semi-solid or formed, it is less and less difficult to take care of the artificial anus and the patient's general condition begins to improve. Operation is instituted considerably later, if necessary.

The care of an artificial anus is of considerable importance to the patient. If the content of the bowel is fluid disagreeable experiences are the rule rather than the exception until such time as sphincteric control becomes slightly developed and the bowel habit is changed. Of all the devices that have come to our notice as satisfactory for colostomy and ileostomy, one devised by a patient on whom we performed ileostomy for polypoidosis of the colon has been the most satisfactory.

Unquestionably patients with polyposis, structures of the bowel, incontinent anus, and carcinoma should have surgical intervention and it is gratifying to know that ileostomy can be performed at a reasonable risk (15 per cent) for such a disease as chronic ulcerative colitis. The risk is really less than this in a case in which it is reasonable to expect a good result and as will be pointed out later with the development of the more recent type of ileostomy considerably less. One of the 2 deaths in group 5 (Table III) was due to diffuse carcinomatosis of the colon and the other was due to peritonitis following repair of the ileostomy.

COMMENT AND TECHNIQUE

The foregoing data seem to be ample evidence that surgery has failed to be of great benefit in many cases of acute ulcerative colitis, and they furnish proof that it is indicated, apparently in only the chronic, complicated long standing cases, which have failed to yield to medical, dietary and other therapeutic agents. We have not shared the optimism concerning satisfactory end results following appendectomy and colectomy which a review of the literature would indicate to exist. Unquestionably many patients have been benefited by these procedures but the rationale of the operation is questionable and certainly if any patient is desperately ill with chronic ulcerative colitis much is asked from any type of operation. One might readily question subjecting the patient with the acute fulminating type of disease to surgical procedures, and, indeed a statistical study of the end results makes it rather plain that little is to be expected from this type of treatment. *Ileosigmoidostomy* (17) has been fairly frequently mentioned in the literature and in the past it has been accomplished successfully in many instances, so far as the operative mortality is concerned. It is our belief that this type of procedure in cases of chronic ulcerative colitis, should be mentioned only to be condemned.

Our experience indicates that chronic ulcerative colitis is initiated in the large bowel, almost invariably from the rectum upward. True there are sporadic instances of markedly

localized chronic ulcerative colitis and other instances in which apparently it has been found in its earlier stages in the right and middle segments of the colon but for all practical purposes, one may consider it a disease which begins in the rectum and progresses toward the cecum and ileum. To attempt to make an anastomosis in a sigmoid which is infected with chronic ulcerative colitis is hazardous from the standpoint of immediate operative mortality and there is little reason to believe that a high percentage of such patients would receive even transitory benefit from side-tracking the greater part of the large bowel by this method.

We have preferred to use ileostomy without exploration in the more acute cases in which operation seemed imperative. With increasing experience we have found a decided falling-off in the number of cases selected for operation so that during the last year in The Mayo Clinic, ileostomy has been performed only twice. The unsatisfactory end-results have been a deciding factor in abandoning surgical procedures in the acute, fulminating cases, and in limiting them, so far as possible, to the group of cases which on account of their chronicity complications, and marked disability of the patient indicate radical measures for relief. A corollary to this statement is that chronic ulcerative colitis in its later stages, must be classified with the condition which not infrequently demands extirpation of the colon because of the development of multiple fistulas, abscesses or polypoidosis, which we believe to be a precursor of a malignant condition. Because of the fact that in many instances in this type of case it is desirable and frequently necessary to perform subtotal colectomy or possibly total colectomy following preliminary procedure, we have found it advantageous to change the technique of ileostomy somewhat from that employed in former years.

When Brown advocated a double barreled loop ileostomy for chronic ulcerative colitis, the technical difficulties of the operation were markedly facilitated in cases in which operation was imperative. However with the evolution of ileostomy it has seemed to us decidedly more satisfactory to institute single

trolled hip joint on the opposite side, would have rendered standing difficult, if not impossible. Stiffening in the straight position likewise would have prevented a good sitting position. This represents a case of when to let well enough alone and not to operate. The axiom of an old time professor of surgery, "if you can't do some good, don't do any harm," was never better illustrated.

Fourth, the present and future social status of the afflicted person should also be taken into consideration in prescribing the surgical reconstruction scheme. Younger surgeons trained in the technique of operative procedures and without long experience and contact with social, business, or industrial aspects of their patients' lives are too likely to give the latter but scant consideration and may not weigh the factors in their proposed operations against the future social status of the individual. Such procedures as arthrodesing knees, hips, shoulders, and wrists should be most thoughtfully considered, first, as to whether or not they should be recommended at all, if so, at what age, and when done what should be the choice of angles at which to fix them.

For illustration, a beautiful girl of 11, with double dangle legs has been in double full length braces for a period of 1½ years, undergoing muscle re-education and training, with the result that no return shows in the feet, only a very slight bit at the knee and some in the thighs, but with only about 40 per cent strength. The senior surgeon decided upon and carried out a bilateral Whitman astragalectomy. He was questioned as to his reason for doing this in the face of the fact that the girl would probably have to wear braces always. His purpose was made clear when he stated that knowing the social status of the family and the probable future position of the girl he did the procedure because it was sound technically, the knees would be more or less stabilized and there was some likelihood that the abductors of the hip joints might in time reach a strength to allow them to be shifted back to aid the glutei.

Furthermore these feet could be safely shod in low shoes, and sheath type braces with lock stops to control knees and extending only to the skirt length could be worn for dress affairs without showing. The feet thus shod would be presentable and braces would not be in evidence. Later spinal fusion or plastic repair of abdominal insufficiency may still further decrease this girl's disability.

Every one of the poliomyelitis cases should have a well thought out surgical plan based on possibilities and probabilities 10 or 20 years ahead. Each step bears directly on the next. Hence care in not doing too much, and especially not out of sequence, is necessary. After each procedure or series of steps the adaptation of the new mechanical situation to school and social needs becomes necessary. As the child develops, new demands may show the need of further surgery, to withstand increasing weight and activity, or economic and social necessity. Many final or end opera-

tions of a radical type like those mentioned should be planned or done late enough to determine their absolute necessity or advisability.

As an illustration of improper sequence in relating surgical steps note the following case of paralytic equino valgus, in a girl of 13.

Patient was seen by senior consultant. Recommendation already given was tendon lengthening of Achilles and transposition of peroneus longus to midtarsal region, second step, tarsal stabilization. Advice was given to do the heavy bone work of stabilizing operation as a first step and then the transplants later to avoid danger of complications.

The foot ought not be used in a position of deformity during the period necessary for re-education. Consequently, the early need of the arthrodesing procedure, and this would require 8 weeks in plaster, which would give time enough for atrophy of the transplant with stretching of adhesions. Furthermore, the swelling incident to the latter operation and probability of secondary closure of the dorsolateral incision with a large binding scar not far from the transplant insertion might easily vitiate the entire value of the first procedure. Hence, it is a safe rule to do all deformity correction of bones and joints first and follow by those procedures which deal with re-adaptation of power.

To illustrate the possibilities over a period of years, let me cite one severe case.

A D, paralyzed at 8½ years of age. Both legs, abdomen, and trunk in the lower segment, with the following deformations: advanced scoliosis, pelvis tilted forward and down on the right side, overactive Achilles and peronei, both feet, with weak anterior tibials producing equino valgus, with marked instability and toe drop. Beginning knock knee on both sides with rotatory deviation of the tibia at the knee because of a tendency to overaction of the biceps and overextension on tensor fascia femori, paralysis of the lower half of the abdominal muscles. Patient could stand by use of crutches and with them walked with great instability and lack of security. The following brief résumé of reconstruction illustrates what persistent, thoughtfully planned procedures could accomplish to meet the original condition, anticipate and prevent the effects of deforming forces, and obtain gradually increasing function until at 17 years she has managed to keep up in her grades at school and can sit and stand longer times without fatigue, attend social and school duties, has become practically independent in getting around on short crutches, and lately has begun to stand alone in leg braces without crutches and take a few steps just holding lightly for balance.

September, 1923, to March, 1925, re-educational muscle training.

March 10, 1925, right foot, tarsal arthrodesis, transplant of the extensor proprius hallucis to anterior tibial insertion, peroneus longus to scaphoid. Physiotherapy until November, 1925.

November 3, 1925, left foot. Tarsal arthrodesis. Transplant peroneus longus to scaphoid. Followed two years of gymnastic treatment, underwater muscle training, braces, casts, etc.

medics weak; able to stand with caliper ring split and two-inch raise on heel and sole. It was desired to get patient out of brace which called for foot stabilization and an arthrodesis of the knee. A report was requested from the psychologist as to the future intellectual and vocational outlook of the boy. A report was returned stating that the boy was of a "dull social mentality and could never be a brain worker." On the basis of this report these operations were done, and the boy was made brace free. Shortly afterward he returned to his home town, obtained job at a service station where he has been satisfactory employee for several years.

X, boy aged 14 years; poliomyelitis, chronic, involving one leg; atrophy shortening 3 inches, contracture deformity at the knee, equino varus severe in foot. Operations for correction of deformity gave very satisfactory results. Follow-up of muscle re-education failed to give any power at the knee. He had a nominal limp in brace and high soled shoe. One of the younger surgeons felt that probably an arthrodesis at the knee would make him free of the brace. The record showed his father to be a plasterer. Patient was sent through for an opinion from a senior surgeon, and a report from the psychologist was requested. Advice was returned that the boy was distinctly a mental type with a high intellectual quotient and that he had marked bent toward some artistic career. As result, operation was advised against and the boy sent home, wearing a brace with lock stop at the knee joint.

The tendency for some surgeons to perform arthrodesis of hip or knee joints without specific knowledge (as far as can be obtained) can, especially in clinical practice, produce untold harm to the future vocational, social, and mental outlook. Ask a doctor lawyer, or business executive, with a knee stiff from injury or arthritis, what the handicap means, and one will readily understand that such a condition should not voluntarily be produced except as a necessity or choice after very mature deliberation. Never should it be done early in life in a paralytic until an intelligent effort has been made to evaluate the future social-economic needs and possibilities.

Second the closer the child is to adolescence and the beginning of the working age, the more careful should the surgeon be to acquaint himself with the family background. Proper social service reports, plus the report on the individual's mental and vocational possibilities will often determine the most advisable surgical procedures. A succession of separate operative steps preceded and interspersed with physiotherapeutic treatments over a 2 or 3 year period might be ideal in certain circumstances, but in a family in a bad economic situation, with the father perhaps dead, or having deserted the family and the mother working, radical procedures to give stability reasonable function, and early possibility of work should be decided upon.

We recall certain early criticisms of the work of Hoke and Campbell in the south for the exten-

siveness and apparent radicalness of some of their surgery but an intimate knowledge of the social problem they have so bravely attacked showed that the majority of terrible paralytic deformities in young adults and children of poor mountain families necessitated this type of radical surgery to meet the absolute economic and social need presented.

There would not be time and money available to do what some might consider a more conservatively indicated course of procedure hence the criticisms, without intimate knowledge of all the facts to be weighed were unjust.

Third, the industrial aspect of each poliomyelitis case nearing working age should receive careful consideration. We have already mentioned the individual aspects in the way of mental equipment, etc., but the surgeon should have some hesitation in performing operations which might render it difficult to execute certain motions essential to an occupation for which the individual might be otherwise well suited.

For instance, arthrodesis of a shoulder may be well indicated but the position in which the shoulder should be permanently fixed may vary considerably according to the occupational requirement and also in accordance with right or left handedness in relation to which shoulder is involved. Likewise with some involvement of both shoulders, which one to stiffen requires good judgment, based on the existing hand and elbow function or the degree of possible function in connection with wrist arthrodesis or transplantation.

This operation is often done quite early without due regard to future occupational possibilities or necessities.

As an instance of the need for caution let us cite the case of a young doctor who some years ago suffered an attack of poliomyelitis, with resulting extensive, belated leg and trunk paralysis. He was advised upon consultation with a surgeon of outstanding operative ability to have an arthrodesis of the hip and knee on one side, to allow him to stand. Fortunately, he did not take the advice and ultimately made fine success as an internist practicing from his wheel chair. He did not have the possibility of doing anything much else without low back and abdominal musculature sufficient at least to avoid fatigue and what would have been his present status had he followed this advice and been unable to sit? His arthrodesis, even in a semi-sitting position, would have been useless for standing and would have required knee arthrodesis at a corresponding angle which would have raised the foot 4 to 6 inches from the ground, which, with an uncon-

FROM THE MICHAEL REESE HOSPITAL

PELVIC DIAGNOSIS BY ROENTGEN VISUALIZATION

IRVING F. STEIN, M.D., F.A.C.S., CHICAGO

A DECADE is usually required after the description of a new method of diagnosis or treatment before its general acceptance, and although it is just ten years since Peterson's description and recommendation of gynecological pneumoroentgenography, there is already considerable evidence in the literature of its widespread adoption by the profession.

Impelled by the conviction that pelvic visualization is a method which well merits the attention and serious consideration of surgeons practicing gynecology as well as all roentgenologists, we desire to describe the technique of this diagnostic procedure as it is employed at the Michael Reese Hospital, Chicago, and where we have utilized it for the past decade. Pneumoperitoneum was introduced in 1902 by Kelling who injected air into the peritoneal cavity to visualize the abdominal viscera for endoscopy. Later, Jacobaeus tried the method on a series of cadavers and demonstrated that no visceral injury was inflicted by the abdominal puncture. Subsequently, he reported successful results in one hundred living subjects in which no infections and only one case of bleeding was encountered. In his monograph on abdominoscopy published in 1913, he first called attention to the great advantage of combining pneumoperitoneum with a roentgen examination. Orndoff made use of this combination in over one hundred cases and published a beautifully illustrated article on the subject in 1919. He substituted oxygen and nitrogen for air for inflation, and employed chiefly the dorsal and lateral postures in making roentgenograms. There is evidence also that he used the prone position with the hips somewhat elevated for pelvic exposures. Weber, Lorey, and Stein and Stewart (13) were also pioneers in the development of this field of diagnosis.

Carbon dioxide, which has become the medium of choice, was first introduced for the production of pneumoperitoneum by Alvarez, in 1920, who also described the visualization of the uterus and ovaries on the roentgen film after placing the patient in the Trendelenburg posture, thus permitting the gas to surround the pelvic viscera and to displace the intestines.

In 1921, after 10 months' experience with diagnostic pneumoperitoneum in gynecology,

Peterson reported favorably upon the method to the American Gynecological Society and recommended its utilization. He not only employed the transabdominal route of abdominal inflation, but also adapted the Rubin patency technique to transuterine inflation. He placed his patients in a modified knee-chest position for radiography thereby obtaining better pelvic visualization than had previously been described. Peterson proved by cultures that both oxygen and carbon dioxide were bacteria-free as they escaped from the needle, and also by the fact that there were no instances of peritoneal irritation in the 300 patients whom he inflated. Commenting upon the value of pneumoperitoneum as a diagnostic aid, Peterson says: "It certainly has been surprising to see how often it has been impossible to determine accurately by the examining finger the exact condition of the pelvic organs. I failed to realize how much I was depending upon the opening of the abdomen to clear up fine points in diagnosis. All this has been changed since roentgenography of the pelvis has been utilized as an aid to diagnosis." Yung also emphasized the value of pneumoperitoneum in gynecological diagnosis, stating that by this method a better differentiation between simple follicle cysts and ovarian tumors can be made, and that conservatism in surgical treatment of myomata during the reproductive period may be clearly indicated. He points out the value of demonstrating normal pelvic findings to exclude pelvic adhesions, a diagnosis which leads to so many unnecessary operations. A great many publications have appeared on this subject in this country, in continental Europe, and in South America, in all of these contributions the advantages of pneumoroentgenography have been stressed. Accidents have been exceedingly rare—about one in two thousand cases—and were usually due to careless technique. Large amounts of gas or air (6 to 8 liters) as used by Carelli, however, are dangerous and are entirely unnecessary for diagnostic purposes.

Our experience with pneumoperitoneum at Michael Reese Hospital began in 1923, and our first report (14), published in this journal in the January issue of 1926, described its use in 150 patients. In October of that year we published a preliminary report on the combined use of iodized

October 20, 1927. spinal fusion for severe scoliosis. Four months' reconditioning and muscle training.

July 17, 1928. To correct right leg, back of knee, knock knee and rotation, osteotomy of the tibia, fixation of patella to tibia to form check to back knee. Two years of school work, treatment and training.

February 7, 1930. Transplant of left biceps to patella.

Improvement was continuous but slow. In an effort to overcome the swing of the right leg forward and the swaying gait due to weakened trunk fixation, study of the abdominal weakness induced us to do a fascial plastic of the abdominal musculature, transplanting fascia lata strips from the upper healthy portion of the rectus abdominis to the symphysis and another across out and down from above the umbilicus to the sagging right ilium at the anterior superior spine. This was done July 7, 1931.

At the present writing she clears the floor by 2 inches with the right foot; does not sway as much, can stand alone in leg supports without crutches, and can begin to take few steps without help.

Here we have a kaleidoscopic view of the life of a nearly helpless girl of 8 through 9 succeeding years, now a young lady in high school still improving. When her mother said, before her

last operation was scheduled, "Oh, Doctor do we *have* to have any more operations?" she only protested, "Gee, Mother some of the kids have had seven or eight—I've only had five!"

SUMMARY

Plan for twenty years ahead.

Adapt your surgery to the social, industrial, and economic needs.

Consider the family situation.

Consider the existing mental states in relation to future possibilities.

Each operative step bears a definite relation to future ones and may lead to future modification of your tentative plan.

Attack the key situation first and maintain the correct sequence.

Never say "nothing can be done" rather there is nothing I can do at present" (when the possibilities seem slight). Perhaps a better qualified surgeon could do a great deal.

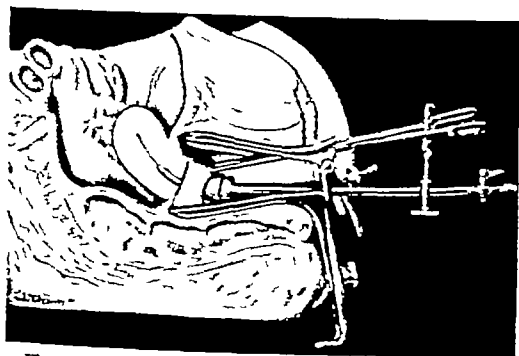


Fig 1 Author's self retaining cannula, *in situ*, for 10-ozed oil instillation, patency test or transuterine inflation

PROCEDURE

The patient is first placed in the dorsal position with the knees drawn up and separated. A roll pad is placed under the buttocks (Fig 4). The sterile bivalve speculum is inserted into the vagina and spread so that the cervix is exposed. The vagina and cervix are then coated with a 2 per cent aqueous solution of mercurochrome (preferable to tincture of iodine because it does not burn and does not obscure the cervix), and the anterior lip of the cervix is grasped with the short tenaculum. The length and direction of the cervical canal are determined by means of a sterile uterine sound. Upon this information depends the choice of cannula (long or short tip) and the relation of the vertical spring to the cannula curve (Figs 5A and 5B). A small wire track along the cannula shank prevents the vertical spring from rotating about its axis. When the cannula is in place with the soft rubber acorn against the external os, the tenaculum lock is engaged in the vertical spring, and by adjusting the latter the cannula becomes self-retaining. The speculum may now be removed if desirable.

The tubal patency test may now be carried out by the usual technique, care being taken to permit the gas to flow very slowly and not exceeding 200 millimeters of pressure. If patency obtains a liter of carbon dioxide is introduced into the abdomen by this means. If obstruction is apparent, the abdomen is prepared with alcohol-mercurochrome solution and a peritoneal puncture is made with a modified (rigid) lumbar puncture needle through the left rectus abdominis about 1 inch below the level of the umbilicus and 1 to 2 inches to the left of the median line. The needle is held perpendicular to the skin surface and with steady finger pressure three distinct layers of resistance are met. The first and greatest is the skin itself. After this has been

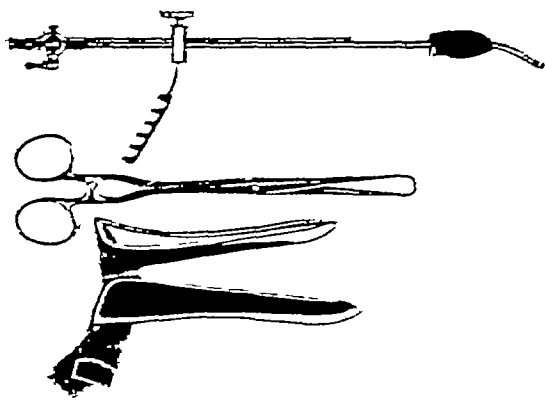


Fig 2 Cannula set with a side-opening speculum which may be removed before roentgenography

passed the needle point advances readily until the fascia is reached when again slightly increased pressure is required. A little beyond a less resistant but distinctly painful layer, the peritoneum, is punctured by a short, quick thrust. The pain is only momentary and is a good indication that the needle point is intraperitoneal. The tube from the volumeter is then attached to the adapter on the needle handle and the inflation is readily made. One may use a greater rate of flow of the gas through the puncture needle than with the transuterine route, the pressure in the manometer remaining at a low level, and the amount of gas used is measured by the number of oscillations of the volumeter. We use a 25 cubic centimeters volumeter for this purpose and usually count 40 oscillations for abdominal inflation. Small or thin subjects may require less than 1 liter of gas, but few if any require more. Immediate withdrawal of the needle after in-

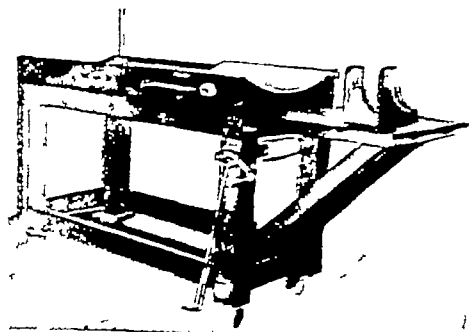


Fig 3 Author's radiographic table suitable for obtaining pelvic mentograms with the patient in the partial knee-chest position.

oil instillation and pneumoperitoneum, and have since then reported a satisfactory experience with this modification in a large number of patients.

During the development of our present technique we devised a self retaining instrument (15) (Fig. 1) to facilitate the performance of the Rubin patency test, for oil instillation, and transuterine pneumoperitoneum. This instrument has since proved entirely satisfactory. In addition to the modified Graves speculum used in the set we now have added a "side-opening" speculum (Fig. 2) which may be removed without disturbing the self retaining cannula. The purpose of this is to eliminate the shadow of the speculum on the roentgen film which occasionally obscures some portion of the pelvic picture if the speculum is retained while the roentgenograms are taken.

Our early attempts with pneumoperitoneum were rather awkward, as it was difficult to maintain the patient in a knee-chest posture and still use a Potter Bucky diaphragm close to the patient's abdomen. This led to the development of a suitable roentgenographic table (16) which we described in the *American Journal of Obstetrics and Gynecology* in 1929 (Fig. 3). With the above armamentarium and the addition of a simple volumeter which is used with carbon dioxide for tubal patency tests, we have continued to use both the simple pneumoroentgenography and the combined iodized-oil (Ipiodol) instillation and pneumoperitoneum in well over one thousand cases.

All of the members of the gynecological department of Michael Reese Hospital are entirely familiar with the methods, and in co-operation with the roentgenologist, Dr. R. A. Arena, make frequent use of them. As we have previously stated, these are not routine methods of examination but are useful in establishing a correct pre-operative diagnosis in many puzzling cases. The differences in opinion which frequently arise in diagnosis on a gynecological service are commonly settled in our group by satisfactory pelvic roentgenograms rather than by an exploratory operation. Furthermore, our internes and the students who come to us as clinical clerks appreciate the great teaching advantage of such lucid pelvic visualization and they frequently inquire why greater emphasis is not placed upon it in the medical schools. Their increasing interest in a diagnostic procedure which is so impressive and valuable will doubtless result in its adoption by all teaching institutions where it is not now being utilized.

CONTRA INDICATIONS

The following conditions contra-indicate the *transuterine route* with either gas or iodized oil for the patency test, abdominal inflation, or utero-salpingography: (1) pregnancy—apparent or suspected, (2) bleeding from the uterus, (3) purulent discharge from the cervix or vagina, (4) acute or subacute pelvic or abdominal inflammation, (5) pelvic tumor or mass completely filling the true pelvis, or a swelling 5 inches or more in diameter.

For the *transabdominal route* of inflation the first three conditions listed above are not contra-indicated but the two latter hold for either method. In addition the age and general condition of the patient shall be considered. We have used transabdominal pneumoperitoneum in girls from 13 to 16 years of age with satisfactory results. On the other hand we have avoided its use in elderly women, those with cardiac and pulmonary disease and patients at any age who were debilitated.

While not directly contra-indicated pelvic visualization is not needed when the ordinary clinical means of diagnosis prove sufficient. However in case of medico-legal issues the pre-operative roentgen evidence may be of great value.

PREPARATION OF THE PATIENT

In order to obtain the most satisfactory results, hospitalization for 24 hours is desirable. While this is not absolutely essential, it serves to minimize the discomfort caused by the abdominal inflation and allows time for a series of films to be taken over an extended period in order to reach a decision in cases of questionable tubal obstructions. It is desired that the lower bowels and bladder are empty at the time the films are made; therefore a soap-suds enema is routinely administered about 1½ hours before examination, and the patient is urged to void the urine immediately before going to the X-ray room. About three-quarters of an hour before the examination the patient is given by hypodermic injection ⅙ grain of morphine sulphate and 1/150 grain of scopolamine and is kept in a quiet, darkened room with her eyes covered. She is transported to the X-ray department on a cart and is assisted to the table with as little disturbance as possible. By this means many patients doze throughout the procedure and are free from any marked discomfort. There are always some patients who do not respond to the analgesic-hypnotic dose but even in these women the discomfort of peritoneal distention is not great or prolonged beyond a few minutes.



Fig 7A Incorrect and correct technique of pelvic visualization. Lipiodol alone was used and films taken immediately. Result not diagnostic



Fig 7B Combined pneumoperitoneum and lipiodol instillation films diagnostic of right tubal mass resembling ectopic pregnancy (Hematosalpinx found)

of lipiodol is added, but only in case the oil flows easily. Additional films are made in half an hour, 1 and 2 hours, the instrument having been removed meanwhile, and if they do not definitely show intraperitoneal spill, films are taken after 18 to 24 hours. Only in this manner may one avoid false conclusions regarding tubal non-patency and the location of tubal obstruction (Figs 7A and 7B)

After the first series of films have been taken the patient is assisted in rolling back on to the

cart (without a pillow) and is lifted or helped into bed. By remaining flat or with the hips slightly elevated for a few hours shoulder pain can be entirely avoided and when patient remains in the hospital over night all of the gas has been absorbed. There is rarely any complaint of discomfort

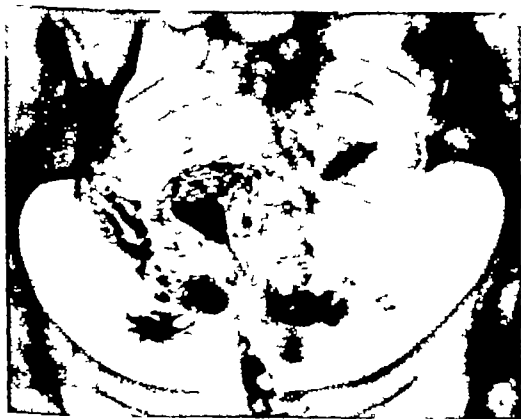


Fig 8 Uterine sinuses and pelvic veins containing lipiodol after uterine injection. Although no harm resulted such errors may be avoided by careful technique



Fig 9 Visualization of the pelvic viscera by means of combined uterosalpingography and pneumoperitoneum. (Author's method)

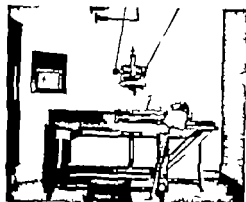


Fig. 4. Patient in dorsal posture on table for patency test, lipiodol instillation, or transterine instillation.



Fig. 6. Patient in correct modified knee chest position on radiographic table for pelvic pneumoerostography

flation prevents escape of the gas from the abdomen. Carbon dioxide absorbs rapidly so that it is not necessary to deflate the abdomen after the films have been made.

Where it is desirable to utilize pneumoperitoneum in diagnosis, the patient is assisted in turning about to assume the knee-chest position, care being taken to keep the head and shoulders lower than the hips. This permits the gas to accumulate about the pelvic viscera, and the abdominal organs to fall toward the diaphragm. Manipulation of the abdomen is useful in "shaking" the intestines out of the pelvis. The patient's shoulders are next adjusted against the shoulder rests with her arms extended over the head, and the movable end of the table is lowered to a suitable degree. The thighs, meanwhile have been elevated upon the pad that previously supported the buttocks, the knees slightly bent, and the back in lumbar lordosis, thus maintaining the patient in a modified and tilted knee-chest posture (Fig. 6). This position has been found most suitable for pelvic roentgenography. Stereoscopic and direct films are now made—usually three films are taken.

If iodized oil (lipiodol, iodipin, etc.) is to be used in combination with pneumoperitoneum the instillation may be made before or after turning the patient from the dorsal to the prone posture. Frequently 3 cubic centimeters of lipiodol is instilled into the uterus with the patient in dorsal posture and one film is taken after which the patient is turned in the desired posture and then an additional 2 cubic centimeters of the oil is injected, provided there is no resistance to the flow. If any obstruction is met, no force is used. The injection is stopped and the films are made as with simple pneumoperitoneum. A 10 or 20 cubic centimeter Luer syringe is adequate in experienced hands for the instillation of iodized oil. For the inexperienced, manometric control is advisable (Jarcho).

The patient is left in this position for a few minutes while the first set of films is being developed and interpreted. If there is evidence of obstruction to one or both fallopian tubes, a series of films is made to determine whether the obstruction is functional (spasm) or is pathological. Sometimes an additional 1 or 2 cubic centimeters



Fig. 5A. Self-retaining cannula adjusted for anteverted uterus



Fig. 5B. Self-retaining cannula adjusted for retroverted or retroflexed uterus

WIRE TRACTION IN FRACTURES OF THE LOWER EXTREMITY

RALPH M. CARTER, M.D. CHICAGO (Former Jan. Wisconsin)

THE end-results in fractures of the lower extremity, particularly in fractures of the femur, frequently leave much to be desired from the standpoint of functional restoration. Consequently any method of treatment which offers an improvement in end-results and which is at the same time relatively simple and easy of application merits serious consideration.

Such a method is skeletal traction, applied by means of the Kirschner wire. In this paper, I wish to show the excellent results which may be obtained in the great majority of cases without open operation, with ease and comfort to both physician and patient, and to urge that those surgeons having much to do with fractures familiarize themselves with the method and utilize it in proper cases. The results to be obtained will be a source of great gratification to all concerned.

The principle of skeletal traction in the treatment of fractures is not new, but the methods of applying it have undergone many changes. Space will not permit a review of the historical field, although this contains much of interest. Briefly, it may be said that skeletal traction was first put upon a practical basis when Steinmann proposed the method which is now known by his name, and which he first demonstrated in June, 1907, before the medical society of Bern. Although he was by no means the first to use the perforating nail for purposes of traction and extension, he so simplified the procedure as to render it widely applicable and generally successful when properly carried out in those cases in which it is indicated.

It is of interest to note that his method when originally proposed was met with a storm of opposition and criticism, which has not entirely subsided at the present day. This opposition, then as now, arose from those unfamiliar with the method and its possibilities and the objections were based chiefly upon the danger of infection.

ADVANTAGES OF SKELETAL TRACTION

In all cases in which continued weight extension is necessary, properly applied skeletal traction offers many advantages over the methods commonly employed. Briefly summarized the outstanding ones are as follows:

1. Since traction is direct none of it being taken up by the intermediate soft parts, much less weight is required to effect reduction and overcome shortening.

2. Traction is regular and continuous, which it must be to be effective.

3. Properly applied, the method is entirely painless and the patient is comfortable throughout the entire course of treatment.

4. Any degree of shortening can be readily overcome.

5. The lower fragment is at all times under excellent control and can readily be brought into line with the upper one.

6. For the application of traction, few circumstances or points only are necessary.

7. Since this leaves the rest of the leg entirely free, especially in fractures of the femur, active and passive motions may be readily performed at the knee and ankle; these motions, therefore, remain in excellent condition and there is very little stiffness to be overcome at the conclusion of the treatment.

8. The end-results are so uniformly satisfactory that open operation can be avoided in the great majority of cases.

The chief objection which can be urged against the employment of skeletal traction is, of course, that there exists the danger of infection. Certainly with improper and careless technique, infection can occur, but this is also true of any surgical procedure. On the other hand with the rigidly aseptic technique which should always be employed, just as certainly infection can be avoided. This is especially true when a fine pin or wire, such as that recommended by Kirschner, is used. Under these conditions, the danger of infection is practically non-existent. Such a categorical statement cannot be made, however, in regard to ice tongs or clippers, or to the Steinmann nail. In the use of both of the latter instruments infection is much more likely to occur in spite of all precautions. Both the ice tongs and the Steinmann nail produce much more tissue damage than does the wire; in addition the tongs have a tendency to slip and to produce skin necrosis and the nail not infrequently becomes loose after a few days, and may slip likewise. These things may occur no matter how rigorous the technique in the application of the traction and any one of them definitely increases the hazard of infection. Consequently the use of ice tongs or nail is not advisable as a routine measure. The case is entirely different, however, as regards the Kirschner wire.

There have been a few reports in the literature of long retention of lipiodol (Lash, 7 Ries, 11). Our observations (17) indicate that ordinarily all the lipiodol is absorbed from the free peritoneal cavity in about 2 weeks. When injected into a closed cavity such as an hydrosalpinx or into a serous cyst enveloping the fimbriated end of the tube one might expect lipiodol to remain unabsorbed for an indefinite time. Apparently no harm is done by long retention of lipiodol (Forester).

Fortunately lipiodol is harmless even when injected into the blood stream, and intravenous injections have been utilized for roentgen visualization. In rare cases lipiodol has been injected into the uterus and has promptly filled the uterine sinuses and has been found ascending the pelvic veins (Fig 8). Even though no harm resulted from such injections, undue pressure in an apparently obstructed utero-tubal canal is to be avoided. A judicious selection of patients, after consideration of the menstrual history and a careful general and pelvic examination, and a

deliberate and painstaking technique are essential to obtain satisfactory diagnostic roentgenograms (Fig. 9)

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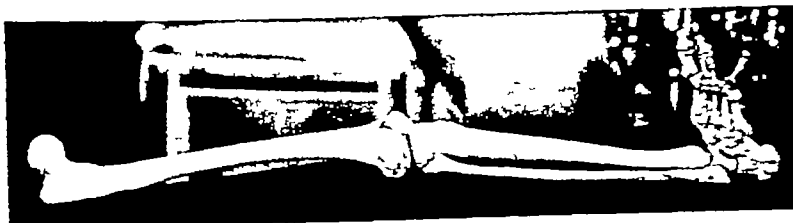


Fig 4. Various points for application of wire traction viz above femoral condyles through tibial tuberosity, and through os calcis

extremity can be satisfactorily treated and an excellent functional result secured without any operation more formidable than that required for the insertion of the wire. It should be clearly understood that I am excluding from this discussion fractures of the femoral neck, these constitute a separate class, and while skeletal traction may sometimes be employed with advantage in certain cases, it is by no means indicated in the great majority of such fractures, consequently, they do not here enter into consideration. But to all other fractures of the shafts of the long bones which require traction, this method is applicable

TECHNIQUE

Before the traction is applied, the bed is first of all prepared by placing several boards crosswise beneath the spring to prevent localized sagging when the splint with the traction weight rests upon it. The foot of the bed is also elevated, so that the body may act as a counterweight. If traction pulleys are not incorporated in the splint, it will also be necessary to have an overhead frame, or other pulley support at the foot of the bed.

Fractures of the femur In fractures of the femur, the wire may be put through the bone just above the condyles, or through the tuberosity of the tibia, the choice of location depending largely upon the situation of the fracture and attendant injuries of the soft parts. In the case of a fracture of the condyles themselves or one immediately above them, or in the case of an infected wound or of great destruction of tissue in the immediate vicinity, or if putting the wire through the bone involves traversing the fracture hematoma, it is clearly obvious that another location should be chosen. This alternate location is the tibial tuberosity just below the attachment of the patellar ligament (Fig 4)

The application of traction above the condyles is the procedure of choice. It possesses two distinct advantages: direct control of the lower fragment is assured, and the traction may be safely left on for much longer periods than when it is

applied through the tibial tuberosity. In the latter position all the traction is necessarily transmitted through the knee joint and its component structures; some authorities feel that this does no harm and statements to this effect may be found in the literature. It is argued that the knee joint itself particularly its capsule is but comparatively little affected by the traction and that the effect of the pull is really exerted upon the thigh muscles which insert below the knee. This is undoubtedly true for relatively short periods of traction but if continued too long, eventually the capsule will feel the strain. Four weeks would appear to be a safe limit; no harm will be done to the knee joint in this period, but at the end of it, some form of indirect traction should be substituted for the wire. By this time, some callus will have formed, and the substitution may be fairly easily carried out.

The wire is put through the bone under the strictest aseptic precautions. This is one step in the procedure which admits of no compromise. In my work, the patient is always taken to the operating room, and the field is prepared as for a major operation. Thorough scrubbing on the part of the operator, and the use of sterile gown and gloves are never omitted. A light gas anesthetic is all that is necessary. After the wire is in place

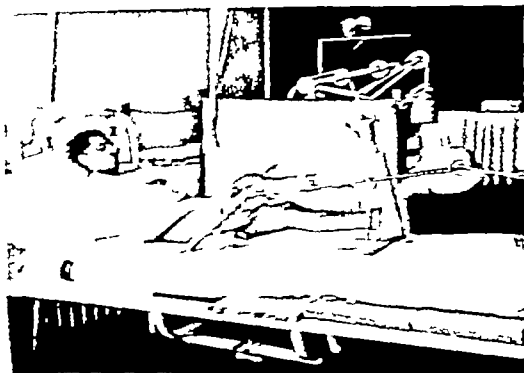


Fig 5. Treatment of fracture of femoral shaft.

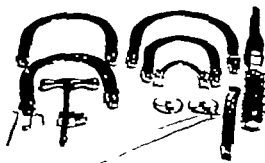


Fig. 1. Kirschner apparatus for application of skeletal traction, showing extension holder, traction bows, wires, and wire tightener as described in text.

Other objections to skeletal traction are of comparatively little importance. At first sight the procedure would appear to be a very heretic one, as a matter of fact, through and through skeletal traction is absolutely painless. It has been argued that important structures may be injured by the passage of a perforating nail or wire such a danger does not exist if the operator possesses the proper anatomical knowledge. Finally, it has been asserted that delayed union is more frequent following the use of skeletal traction. This depends entirely upon a proper approximation of the fragment ends. If they are in good contact union will occur with normal rapidity on the other hand if there is a diastasis of the ends, union will probably be delayed, and may be absent. Thus, however simply emphasizes the necessity for frequent observation by means of the X-ray until the exact amount of weight necessary is found.

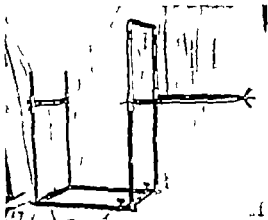


Fig. 2. Screw extension apparatus of Baehler.

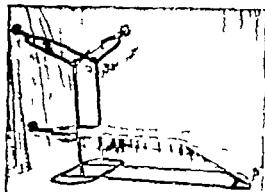


Fig. 3. Baehler split ready for use.

DISCUSSION

Substitution of the perforating nail by a fine steel wire is the latest link in the long chain of technical procedures for the treatment of fractures. Theoretically and practically it represents one of the greatest advances of recent years in this field. Traction by means of a perforating steel wire possesses all of the advantages of skeletal traction in general and in addition, has some of its own. Since the wire is drill-pointed, it is much easier to put through the bone than the steel pin which must be driven through by means of a hammer or mallet. Because of the fineness of the wire, it occasions very little change in the bone structure, and on this account may be left in place for much longer periods than the pin, and finally again because of the small size of the wire any possible danger of infection is reduced to a minimum.

Various ways have been suggested for putting the wire through the bone and for applying traction the apparatus of Kirschner is one of the simplest and is the one with which I am familiar.

All of the instruments necessary for the application of the traction are illustrated in Figure 1. They comprise the various sizes of steel piano wire, a special so-called "accordion" holder for the wire during insertion, steel bows or bone shoes of various sizes, and a special device for tightening or stretching the wire in the bow so that it will not bend. In addition to these, a Braun split or one of its modifications is required (Fig. 2). For fractures below the knee, a special traction apparatus for holding the leg in extension during the application of the cast is also a convenience and an advantage, but it is not a necessity (Fig. 3).

With this equipment, practically any fracture, open or closed of the long bones of the lower

sufficient After reduction has taken place, in my experience, 12 to 15 pounds are all that is needed to maintain it If more weight seems indicated, however, no hesitation need be felt about applying it, as the wire and other portions of the apparatus will sustain much greater weights than indicated, and the patient will be entirely comfortable Under such circumstances, considerable elevation of the foot of the bed will be necessary, in order to obtain sufficient additional counter-traction from the body weight

The weight necessary to produce adequate traction should be estimated by taking into consideration the age, weight, sex, muscular development, and general physical condition of the patient This amount should be applied at the beginning of the treatment and decreased as indicated, it is a mistake to start with a light weight and increase it With sufficient traction, reduction of deformity and correction of shortening usually take place within 24 hours, as a matter of fact, it is very easy to overcorrect and produce lengthening (Figs 6 and 7) For this reason, during the first few days, until satisfactory position of the fragments is assured, frequent X-ray observations are necessary If lengthening has occurred, naturally the weight must be reduced until the fragments are in contact (Fig 8) When this has taken place, with proper daily inspection of the apparatus, the correction and reduction will be maintained, and further X-rays will be necessary only for the purpose of ascertaining the progress of callus formation Comparative daily measurements of the length of the legs are made by having the uninjured extremity held in approximately the same position as the fractured one, after which the distance is determined between the anterior superior spine of the ilium and the inferior border of the patella

For satisfactory healing, apposition of the fragment ends is essential This is particularly the case in transverse fractures of the femur While it is true that a small gap between the ends will usually be bridged by callus, nevertheless, bony union is delayed, a large gap between the ends may give rise to nonunion For this reason, it must be emphasized that after the shortening has been overcome, careful observations and adjustments of the weight are necessary until the exact amount is found which will maintain the reduction without separation of the fragments

In fractures of the femur, the position of the Braun splint in the bed, and consequently of the leg, is a matter of some importance The time honored rule in the treatment of fractures is to bring the fragment over which we have control

into line with that one whose displacement cannot be influenced, in this case, the upper fragment This can be done only by varying the position of the splint In fractures high up in the femur, the upper fragment is strongly abducted, as a rule, consequently, the splint must be placed in a position of extreme abduction, thus lying somewhat diagonally across the bed In some cases, it may be necessary to arrange a support for the lower and outer portion of the splint outside the bed This strongly abducted position decreases if the fracture is lower down the shaft of the bone, and in fractures of the middle and below the splint lies in the axis of the bed The exact position, of course, is determined by means of the X-ray

In fractures of the femur, the duration of the skeletal traction depends entirely upon the point of application If the wire has been inserted in the region of the condyles, I have no hesitation in continuing the traction for 8 to 10 weeks, or so long as is necessary I have seen no bad results whatever, the wire shows no tendency to cut through the bone, or even to loosen to any appreciable extent For reasons which have been given, the situation is otherwise when the traction is made from the tuberosity of the tibia Under these circumstances, direct traction must be replaced by some other form at the end of 3 or 4 weeks By this time, sufficient callus will have formed in the average case to prevent displacement of the ends of the fragments during the manipulations incident to changing the traction

As a substitute for the wire, indirect traction by means of adhesive plaster will probably be found to be more generally satisfactory My own preference is for the zinc-oxide gelatin paste dressing as used by Boehler Properly applied, it is more comfortable and more secure, functional treatment can also be more readily carried out However, a certain amount of experience is necessary for its application, and if one has not this experience it is better to depend upon adhesive plaster The chief disadvantages of this form of traction are its tendency to slip, and the blistering of the skin produced if the plaster is not smoothly applied or if the pull is unequal However, with the slight change in the weight distribution presently to be described, these disadvantages are almost completely obviated

In applying the adhesive traction, strips should be placed both on the thigh and on the leg below the knee, the latter strips being attached to a spreader distal to the sole of the foot Half of the necessary amount of weight is then attached to the thigh strips and the remaining half to those

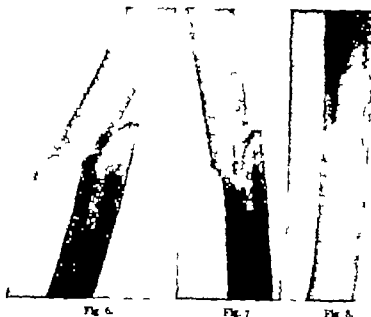


Fig. 6. Fracture of femoral shaft before application of traction.
 Fig. 7. Fracture of femoral shaft 24 hours after application of traction; separation of fragment ends clearly visible, showing that amount of weight is excessive.
 Fig. 8. Same fracture as shown in Figure 6, after weight has been decreased from 30 to 4 pounds.

the extension holder is removed and pledgets of sterile gauze are pushed over the protruding ends, being sealed to the skin with collodion; a few turns of bandage are also used to hold these pledgets more securely in place. Following this, a sufficient number of perforated felt discs snugly but not tightly to fill the space between the traction bow and the skin are slipped over each end of the wire. These effectually prevent side-slip and at the same time do not cause undue pressure on the skin. The traction bow is then applied to the wire, and the latter is tightened by means of the special device; the ends of the wire are cut off close to the bow and the patient is ready to be placed in bed on the splint. The traction bow selected must be somewhat larger than the leg so that a definite space exists on each side between the ends of the bow and the skin. This is highly important if the ends of the bow come in contact with the skin, pressure sores will invariably be produced, greatly increasing the risk of infection, and rendering the removal of the traction necessary.

The position of the leg on the splint is such that the bend of the splint corresponds to the bend of the knee; thus there is partial flexion at both hip and knee. For the purpose of preventing foot

drop and outward rotation of the leg, adhesive plaster strips with a spreader and cord are then applied to the dorsal and plantar surfaces of the foot, the cord being fastened to the splint or to the overhead frame by means of a pulley and a very light weight; thus the patient is at all times able freely to exercise the ankle. The necessary weight for traction is then attached to the bow by means of a light cord and a block of wood or empty box of suitable height is placed at the sound foot of the patient upon this he stands, so to speak, being thus prevented from gradually slipping toward the foot of the bed. In this way a constant traction is at all times maintained.

The patient so treated is immediately comfortable (Figure 5). Whenever he desires, he may make use of a back rest by means of a hand grip suspended from the overhead bar on the frame; he is able to raise himself for the necessary care of the skin of his back and buttocks, and for use of the bed pan.

When skeletal traction is used the amount of weight necessary to effect reduction is decidedly less than that required when methods of indirect traction are used. In fractures of the femur it is rarely necessary to use more than 25 pounds in the beginning, and usually 20 pounds or less are

When it is decided to begin the ambulatory treatment, the weights, traction bow, and wire through the bone are removed. Removal of the latter is a very simple procedure, but here again, strict asepsis is necessary. After removal of the traction bow, by means of a sterile wire-cutting pliers one of the protruding ends of the wire is cut off close to the skin, the short end and surrounding skin is then liberally painted with iodine, the wire seized with forceps on the other side, and withdrawn. The small puncture wounds remaining are painted with iodine, and a sterile dressing applied, which remains in place for a few days. No further attention is required and in my experience, none of these wounds has failed to heal immediately.

In the ambulatory treatment of fractures of the femur, the Thomas knee splint has given me great satisfaction and excellent results. It is simple to apply and very efficient. A supply of Thomas thigh rings of various sizes is kept on hand, and the correct size for the patient is determined by fitting it upon him, the splint is then made up in conformity with the proper measurements of length so that in the erect position, the sole of the patient's foot is one-fourth of an inch above the inner sole of the shoe, all the weight is thus transmitted to the tuber ischi. The sole of the opposite shoe is elevated to correspond. This splint is worn until union is firm, and there is no longer any danger of bending at the fracture site. This usually requires 6 weeks to 2 months, with badly comminuted fractures it frequently takes even longer.

In fractures of the leg below the knee, traction for a period of 3 to 4 weeks is usually sufficient. By this time, a fairly strong callus will be present in the average case, and the traction may be replaced by a cast. In my work, an unpadded cast is applied with a walking iron below the sole of the foot, and the ambulant treatment is begun immediately. The majority of patients learn to walk surprisingly well within a few days. For the first day or two, they are allowed to use crutches, but as soon as possible these are discarded for a cane, and many patients will even dispense with this. This so-called functional treatment undoubtedly shortens the period of disability, when the cast is removed, there is no joint stiffness to be overcome, and the muscles are in excellent condition. However, experience in the application and use of unpadded casts is necessary to avoid pressure sores and other troublesome sequelæ, and, if one has not this experience, it is better to rely on the cast as ordinarily applied. Such knowledge and experience are readily acquired, however, and are

well worth the time and trouble spent in acquiring them.

The cast remains in place for from 4 to 6 weeks, by which time union is sufficiently firm to allow it to be dispensed with. If, upon its removal, the callus is still painful upon weight bearing, bony union is not yet strong enough, and another cast should be applied for a couple of weeks more. After removal of the cast and the beginning of active use, the usual evening swelling of the lower leg and ankle occurs, but is much less marked if ambulatory treatment has been employed. It may be obviated almost altogether by the application of a zinc gelatin paste cast from the toes to just below the knee, immediately following removal of the cast. Patients find this very comfortable, and the moderate, non-rigid support which it gives encourages confidence in their ability to use the injured extremities. Such a cast may be worn for 2 or 3 months, but during this period will require changing several times.

RESULTS

During the past 2 years, my records show that I have used this method of skeletal traction in 30 cases of fracture of the femur, and in 36 cases of fracture of the tibia or of both bones of the leg below the knee. Formerly, a number of these cases, particularly the spiral fractures of the tibia, would have been operated upon, because otherwise, satisfactory reduction and retention would have been impossible. By means of wire traction, all open operations with their attendant risk of infection and prolonged healing period, have been avoided. The end-results, every thing considered are much better than could have been obtained by any other means. Particularly is this true of fractures of the femur. And these results have been secured with much greater comparative comfort to the patients. These statements must not be taken to mean that open operations are never necessary in fractures of the lower extremity, in certain cases they are unavoidable. What I wish to emphasize is the fact that the intelligent use of skeletal traction, applied by means of the Kirschner wire, will greatly reduce the number of cases requiring operation, and that the results obtained in all cases treated conservatively will be as good as those obtained by any other procedure now commonly employed, and in most cases even better.

From my experience, I am convinced that the length of time which is required for functional restoration is definitely less when this method of treatment is employed. To obtain evidence upon this point, a comparative statistical study was

on the lower leg. As stated, such a distribution practically overcomes any tendency to blistering and slipping. During all the procedures involved in making these changes, the wire traction remains active, being released only when the indirect traction is ready to receive the weight. The wire is then removed. When it is desired to exercise the knee, the weight attached to the lower leg is hung temporarily upon the thigh extension, later being again replaced on the lower leg.

Fractures below the knee. In treating shaft fractures of the bones below the knee, the same general principles apply. The method is one which gives particularly gratifying results in spiral fractures of the tibia, which are notoriously difficult to retain even if reduction can be accomplished by ordinary methods, and which consequently are treated by open operation.

The wire is inserted through the os calcis at a point approximately a thumb's breadth below and posterior to the external malleolus (Fig. 4). The leg is then placed upon the splint, the foot suspended as usual, and the traction weight applied. In preparing the splint for a fracture below the knee, one detail is very important and must not be overlooked. In applying the supporting bandage it should be drawn tightly over the thigh portion of the splint, and for one or two turns below the bend of the knee in the region of the calf; however, it should be applied somewhat more loosely to allow for the bulge of the calf muscles, the final turns in the ankle region being again tightly drawn. If this is not done, an anterior displacement of the lower fragment will occur which is almost impossible to overcome. In these fractures, the splint lies in the bed axis. The amount of weight necessary for reduction rarely exceeds 10 to 15 pounds; thus moderate elevation of the foot of the bed is all that is required. In the lower leg fractures, not infrequently lateral displacements are seen which are not entirely overcome by the longitudinal traction. In such cases, lateral traction is easily applied by means of a broad sling about the leg and will usually overcome the displacement. Occasionally it may be necessary to oppose the lateral traction on one fragment by similar traction on the other but in the opposite direction. If under these circumstances, reduction is not readily accomplished it is entirely likely that there is some interposition and the case must be treated by open operation.

Excellent results in fractures of the lower leg are obtainable by the method just described. However, if the necessary equipment is available, the method of Boehler offers some advantages. To apply it properly a screw extension apparatus

is necessary (Fig. 3). The wire is inserted through the os calcis as usual, and the traction bow applied with the wire under proper tension. The leg is then placed in the apparatus with the knee flexed to a right angle; the traction bow is attached to the screw and sufficient traction is applied by means of the screw to effect reduction. An unpadded circular plaster cast is then applied, incorporating the wire. As soon as the plaster has hardened, the screw traction is released, the leg is laid on the splint, and the necessary weight is applied. Immediately thereafter the circular cast is split longitudinally over the anterior aspect of the leg, a proceeding which must under no circumstances be omitted. The foot is suspended to prevent axial rotation of the leg. The fractured leg is thus held much more securely than with simple traction and movements of the patient are unable to disarrange the position of the fragments.

FUNCTIONAL AND AMBULATORY TREATMENT

The ease with which functional treatment may be carried out in fractures of the femur constitutes one of the principal advantages of the method. The patient is able to exercise the foot and ankle from the first day. After the apparatus has been satisfactorily adjusted, and he has become accustomed to it, which is usually by the end of the first week, passive motions of the knee may be begun. For this purpose, the cord which suspends the foot is passed through a pulley on the overhead frame or on the splint, and the end is held by the patient. The cross slings supporting the lower leg are now removed, and the patient is able to raise and lower the foot until it rests on the bed, thus exercising the knee joint and muscles of the thigh. After exercise, the cross slings are replaced, and the foot again suspended as before. At first this may be done for a 15 minute period morning and evening. Later the periods may be lengthened and an additional one added. In the beginning, also, the amplitude of motion should be slight, gradually increasing as time goes on. As the callus becomes firmer the purely passive movements should be supplemented by active contractions of the thigh muscles toward the end of the treatment in bed. It will be found that most patients can flex and extend the leg at the knee with but very little assistance from the cord attached to the foot.

By the end of 10 to 12 weeks, in most cases and sometimes sooner, the callus is sufficiently firm and union is so far advanced that ambulatory treatment may be begun. The time for this is determined by careful clinical and X-ray studies of the site of the fracture.

When it is decided to begin the ambulatory treatment, the weights, traction bow, and wire through the bone are removed. Removal of the latter is a very simple procedure, but here again, strict asepsis is necessary. After removal of the traction bow, by means of a sterile wire-cutting pliers one of the protruding ends of the wire is cut off close to the skin, the short end and surrounding skin is then liberally painted with iodine, the wire seized with forceps on the other side, and withdrawn. The small puncture wounds remaining are painted with iodine, and a sterile dressing applied, which remains in place for a few days. No further attention is required and in my experience, none of these wounds has failed to heal immediately.

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From my experience, I am convinced that the length of time which is required for functional restoration is definitely less when this method of treatment is employed. To obtain evidence upon this point, a comparative statistical study was

attempted, but was abandoned because of incompleteness of earlier records. This decrease in length of disability is to be attributed entirely to the excellent condition in which the neighboring joints and muscles may be maintained during the period of consolidation of the fracture, in cases of fracture of the femur by active exercise and in cases of fracture below the knee by the use of the ambulatory cast. That a condition approximating normal is present is proved conclusively to my mind by means of the X-ray. This shows that the bone atrophy which is almost invariably present in cases which have been submitted to prolonged immobilization is conspicuous by its absence if "functional" treatment has been carried out as described.

For success with this method close attention to essential details is important. This necessitates

frequent thorough inspection particularly in the beginning of the treatment. After a few days, with a little explanation, the average patient has grasped the underlying principles and readily co-operates by himself seeing to it that the traction is at all times active, that the splint remains in the proper position, etc. A single daily inspection is then all that is necessary.

In conclusion it must be emphasized that this is not a method to be employed by the man who treats only occasional fractures. Hospital facilities and surgical experience are indispensable for success. But to those surgeons, particularly industrial surgeons, who are doing considerable fracture work, and who are conscientiously interested in improving the treatment of fractures in general and in securing better end-results, the method can be most highly recommended.

THYROTOXICOSIS IN THE NEGRO

LOUIS G. HERRMANN, M.D., CLEVELAND, OHIO

From the Department of Surgery of Western Reserve University School of Medicine and the Lakeside Hospital, Cleveland

IT is commonly held that thyrotoxicosis is an extremely rare disease in the negro, yet a review of the patients admitted to the Lakeside Hospital because of "goiter" has shown a relatively large number of negroes with a severe form of that disease syndrome. We have been especially interested in studying the variations of this syndrome in a race that is supposed to possess some natural immunity to the more severe forms of thyrotoxicosis. It is quite probable that many of the milder forms pass unrecognized while the severer forms, the type with which we deal in this paper, can hardly be confused with any other clinical picture of disease. It is well known that thyrotoxicosis is most frequently found in people of a high strung temperament, consequently the discovery of this symptom complex in the negro has prompted us to study the train of affairs that seems to precipitate such a disturbance in that race. Bram states that thyrotoxicosis is most prevalent in the Caucasians, particularly among the Hebrews, the Irish, and the Latinic peoples. Mongolians are next in order of degree of susceptibility, the negro being relatively immune.

The problem of the frequency of colloid goiter in the negro has been extensively studied by Cohen, Goldberger and Aldinger, and Mustard and Waring, and their results agree with those of Olesen who found in Cincinnati and again in Colorado that there was no evidence of racial immunity to simple goiter in the colored race. Bram also states that in spite of the fact that simple goiter is more common among the negroes, hyperthyroidism is rarely if ever found in that race.

REVIEW OF LITERATURE

Jones reported 18 negroes with goiter out of a total of 407 patients from his private practice in Georgia, a territory in which the population of the white people is somewhat larger than that of the colored people. Six of the 18 colored patients had true exophthalmic goiter, one had "toxic non-exophthalmic goiter with chronic cardiac symptoms" and the rest had non-toxic adenomata of the thyroid gland. He states that he is of the opinion that goiter is less common in the negro than among white people.

Harris states that during the year 1926 there were admitted to the Shreveport Charity Hos-

pital 5,583 patients of whom 6 were cases of goiter. Grouped according to sex and race there were 2 white females, 3 negro females, and 1 negro male. In the year 1927, a total of 7,467 patients were admitted and of this number 19 had goiter. Grouped according to sex and race, there were 7 white females, 2 white males, and 12 negro females. Of the total number of patients with goiter admitted during the 2 years, there were 9 with exophthalmic goiter, 4 with toxic adenomatous goiter, 10 with colloid goiter, and 2 with non-toxic adenoma of the thyroid gland.

REPORT OF CASES

During the 5 years between July, 1924, and July, 1929, there were 7,421 patients admitted to the Surgical Service of the Lakeside Hospital. Of these patients, 729 had goiter and of this number 571 showed the classical signs of thyrotoxicosis, 358 being classified as having exophthalmic goiter and 213 as having toxic adenomatous goiter. Of the 358 patients with exophthalmic goiter, there were 325 white people and 33 negroes, 12 negro males and 21 negro females. Five negro females and 1 negro male had toxic adenomatous goiter and 1 negro male had toxic non-exophthalmic goiter. Of the group with non-toxic adenomatous goiters there were 5 negro females and 2 negro males. Consequently, of a total of 571 patients with thyrotoxicosis, there were 40 negroes.

In order to illustrate clearly the variations of this symptom complex in the negro, we have selected from the 40 negro patients mentioned, 1 typical example of each of the following five main varieties of the syndrome.

I. THYROTOXICOSIS (EXOPHTHALMIC GOITER)

Approximately three-fourths (72.5 per cent) of our series of 40 negroes were classified as having true exophthalmic goiter. Definite bilateral exophthalmos together with constitutional evidence of thyrotoxicosis formed the basis for segregation into this group. The following case history is presented as a typical example of this group.

CASE 1. P. G. (Fig. 1), single, laborer, aged 33 years, native of Alabama. Patient was admitted to the surgical service on September 11, 1928, because of extreme nervousness, rapid loss of weight, and weakness. In December 1927, he began to have "attacks" of nervousness and he,

became very irritable. He states that he had some "financial trouble" at that time and that caused him to worry a great deal. The nervousness became progressively worse, he began to lose weight, and became completely fatigued after slight exertion. He was soon unable to work even when he could find a job. His friends noticed the increasing prominence of his eyeballs. During the latter part of the summer of 1928 he lost weight with increased rapidity and he became extremely weak. On admission to the hospital, he showed evidence of having lost a great deal of weight. His face and hands were flushed and very warm. Marked bilateral exophthalmos was present, and fine and coarse tremor of the extended fingers was noticeable. Pulse rate (at rest) averaged about 16 beats per minute. Blood pressure 165-90. The thyroid gland was slightly enlarged and soft. A thrill was palpable at both superior poles of the thyroid gland; there was a loud bruit over the entire gland. No adenomata were palpable in the thyroid gland. The heart was slightly enlarged to the left. The rhythm was regular but rapid. There was a systolic murmur at the apex. The radial pulses were equal, regular and forceful. The lungs were normal. No evidence of stasis was present. The urine was normal. The blood Wassermann test was negative. Basal metabolic rate averaged +43 per cent.

Pre-operative preparation of complete rest in bed, high caloric diet, and iodine therapy (potassium iodide grains 15, t.i.d.) was carried out for a period of 15 days. The basal metabolism and pulse rate returned to normal. A subtotal thyroidectomy was performed on September 27, 1928. The postoperative course was uneventful. The patient was discharged from the hospital on October 5, 1928. Repeated follow-up examinations showed no return of the toxic symptoms. The photograph (Fig. 1) was taken several months after the thyroidectomy. There has been no appreciable change in the exophthalmos. In March, 1930, the patient stated that he was able to do a full day's work without becoming fatigued.

II. THYROTOXICOSIS (JUVENILE EXOPHTHALMIC GOITER)

Exophthalmic goiter in children under the age of 12 years is unusual nevertheless we have observed 2 colored children, 1 boy and 1 girl, each aged 7 years, with a very severe degree of thyrotoxicosis associated with marked bilateral exophthalmos. Fright and emotional disturbances seem to play a part in bringing on these symptoms of thyrotoxicosis in children as well as in adults. Lahey recommends a two stage thyroidectomy in children because most of them show a considerable rise in the pulse rate after a one stage subtotal thyroidectomy. He has, however, never observed a severe general reaction nor any signs of a thyrotoxic "crisis" in a child after thyroidectomy. He also stresses the importance of leaving sufficient thyroid tissue to care for the needs of the growing child and to avoid any danger of myxedema.

The one negro child mentioned in this series who was submitted to thyroidectomy showed a marked rise in the pulse rate for several hours after the operation. The complete case history is as follows:

CASE 2. R. D. (Fig. 2) school-boy, aged 7 years, native of Georgia. The patient was admitted to the surgical service on October 9, 1927 because of extreme nervousness, rapid loss of weight, and general irritability. On examination he was found to be fairly well developed but undernourished young colored boy. He was very restless and irritable. There was marked bilateral exophthalmos. The skin of the face was moist and very warm. Both tonsils were enlarged and cryptic. The thyroid gland was uniformly enlarged and moderately firm. N. adenomata were palpable. There was a slight thrill palpable at the left superior pole, but a bruit could be heard at both superior poles of the thyroid gland. The heart was enlarged to the left. There was marked precordial activity. Rhythm was regular; no murmurs. The lungs were normal. The radial pulses were equal, forceful, and the average rate (at rest) was 30 beats per minute. Blood pressure was 120-80.

Laboratory tests showed the urine to be of a high concentration (specific gravity 1.030) and to contain a slight trace of sugar. Blood sugar was 0.8 per cent. Red blood cell count was 4,500,000 and white blood cell count was 6,400. The basal metabolic rate averaged +75 per cent. The blood Wassermann test was negative.

After 15 days of complete rest in bed, high caloric diet, and iodine therapy (saturated iodine and later potassium iodide) the subjective symptoms completely disappeared. The pulse rate returned to normal. The basal metabolic rate fell to +10 per cent, and the blood pressure remained only slightly elevated.

Subtotal thyroidectomy (single stage operation) was performed on November 3, 1927. There was a marked rise in the pulse rate immediately after the operation with only a slight rise in the general body temperature. The pulse subsided of good quality but was very rapid for several hours. By evening the heart rate had returned to about 100 beats per minute and the state of excitability had passed. The remainder of the postoperative course was uneventful. The basal metabolic rate taken several days after the thyroidectomy showed only +1 per cent. The patient was discharged from the hospital on November 20, 1927.

The patient had a similar marked increase in the heart rate following the removal of his tonsils some months later. Careful examination failed to show any evidence of residual toxic symptoms and the basal metabolic rate was still normal. After the removal of the tonsils, the child gained weight and his general health improved greatly. We have been unable to locate the patient for more than a year so that final follow-up data cannot be given at this time.

III. THYROTOXICOSIS (UNILATERAL EXOPHTHALMOS)

The 2 following cases are reported separately because of the interesting history connected with the appearance of the unilateral exophthalmos in relation to the onset of the clinical symptoms of thyrotoxicosis. In the first patient (Fig. 3) the prominence of the left eyeball was present long before a definite clinical diagnosis of thyrotoxicosis could be made. In the second patient (Fig. 4) no exophthalmos was present at the time of the subtotal thyroidectomy but gradually over a period of months after the operation the left eyeball became prominent in spite of the fact

that there was no evidence of recurrent thyrotoxicosis

CASE 3 S D (Fig 3), widow, aged 43 years, out of work, dependent on charity, native of Mississippi. This patient was admitted to the medical service in April, 1929, in a semiconscious condition with high fever (41 degrees C), rapid pulse rate, rapid respirations, and a marked prominence of the left eyeball. Physical examination of the chest at that time failed to reveal signs of pulmonary disease. Early thrombosis of the cavernous sinus was considered because of the marked unilateral exophthalmos. There was no change in the exophthalmos but some hours later physical signs of consolidation of the lower part of the right lung were present. Classical signs of lobar pneumonia then developed. The exophthalmos remained unchanged. Before discharge from the medical service a diagnosis of thyrotoxicosis was made because of the persistent tachycardia (120 beats per minute), increased basal metabolic rate, and the extreme excitability of the patient. She was given small doses of potassium iodide for several days and was then referred to the surgical dispensary for further follow-up examinations. After several months had been allowed for recuperation from the pneumonia she was referred into the hospital on the surgical service for complete iodization and subsequent thyroidectomy. During her convalescence from the pneumonia she received small doses of potassium iodide each day.

Examination showed her to be extremely active, easily excited, and irritable. There were signs of marked vasomotor instability, marked exophthalmos on the left, slight prominence of the right eyeball also. The thyroid gland was slightly enlarged and quite firm. No nodes were palpable. A faint bruit could be heard at the left superior pole of the thyroid. No thrill was present. The heart was normal in outline. Rhythm was regular but rapid. There were no murmurs. Blood pressure was 150-80. The radial pulses were equal, forceful, and averaged about 110 beats per minute. There was a marked fine tremor of the extended fingers.

She dated the onset of the nervousness and excitability to "domestic difficulties" and "financial worries" which apparently reached their climax in the autumn of 1928, about 6 months prior to the attack of pneumonia. She had been trying in vain to provide for her three young children. For months she had been out of work and dependent upon charity. Because of lack of money she was forced to move from the place she had used for her home. The onset of all her present symptoms followed in the wake of this great crisis in her life. She denies ever having been ill prior to coming to the Great Lakes district.

Laboratory tests of the blood were normal. The urine showed many white blood cells but no albumin or sugar. The blood Wassermann test was negative. The basal metabolic rate averaged +82 per cent.

After about 2 weeks of complete rest in bed, moderately large doses of potassium iodide (grains iii, t.i.d.), and a high caloric diet, all the subjective symptoms disappeared. The pulse rate and basal metabolism returned to normal.

Subtotal thyroidectomy was performed on July 15, 1929. The postoperative course was uneventful. Repeated follow-up examinations have shown the patient to be in good health and free from all her former symptoms. She has gained weight rapidly. The unilateral exophthalmos has remained the same. Through the aid of the social service department the financial and domestic troubles of this patient have been corrected.

CASE 4. R J (Fig 4), widow, housemaid, aged 39 years, native of South Carolina. She had lived in Cleveland for 23 years. She was originally admitted to the medical

service because of marked loss of weight, nervousness, and palpitation. A diagnosis of Graves' disease was made and the patient was given iodine in the form of Lugol's solution (m V b.i.d.). After several days, this dose was increased to m XV three times per day. She stated that she had been worrying a great deal during the 6 or 7 months prior to the onset of her symptoms. Lack of money and the inability to obtain work seemed to be the basis of most of her worry.

After about 3 weeks of complete rest in bed and iodine therapy the patient was transferred to the surgical service for operation. Physical examination at that time showed only a slight enlargement of the thyroid gland. The gland was very firm. No thrill nor bruit were present over the gland. No exophthalmos was noted. There was marked increase in the general activity of the patient. The heart was enlarged to the left. There was a loud systolic murmur at the apex that was transmitted into the left axilla. There was a moderate fine tremor of the extended fingers. The radial pulses were forceful, equal, and the average rate was 85 beats per minute.

Laboratory tests showed the blood Wassermann test to be four plus (++++) The red blood cell count was 3,700,000 and the white blood cell count was 5,800. The urine showed a slight trace of sugar and a moderate number of white blood cells. Blood sugar was 0.096 per cent. The basal metabolic rate on admission to the surgical service averaged +35 per cent.

Subtotal thyroidectomy was performed on December 28, 1927. The thyroid gland was found to be well involuted by the iodine therapy. The postoperative course was uneventful and the patient was discharged from the hospital on January 26, 1928.

About one year later the patient was readmitted to the hospital on the urological service because of severe pyelitis. During this severe infection there was no return of the former thyrotoxic symptoms and the basal metabolism remained normal. It was during this admission that the prominence of the left eyeball was noted. The patient stated that during the year that followed the thyroidectomy, the unilateral exophthalmos slowly but constantly increased. The photograph (Fig 4) was taken in February, 1929.

IV THYROTOXICOSIS (TOXIC ADENOMATOUS GOITER)

Six of the 40 negroes showed moderately severe toxic symptoms associated with multiple adenomata of the thyroid gland. We believe that iodine therapy is indicated as a pre-operative measure in all cases in which there exists hypertrophic and hyperplastic thyroid tissue. The temporary involution caused by the iodine makes the subtotal thyroidectomy technically much easier and decidedly much safer. Unless sufficient thyroid tissue is removed, recurrence of the toxic manifestations frequently results. The following case (Figs 5 and 6) illustrates the advisability of performing a subtotal thyroidectomy in patients who show toxic symptoms associated with an adenomatous goiter even when the thyroid gland at the time of operation shows only cystic and colloid adenomata.

CASE 5 E G (Fig 5), widow, housemaid, aged 46 years, native of Kentucky. This patient was admitted to

the surgical service on December 19, 1927 because of loss of weight, shortness of breath, nervousness, and palpitation. Examination showed her to be moderately well developed but very poorly nourished. She was very restless and excitable. Her face and hands were moist and very warm. There was moderate prominence of both eyeballs. She stated that she had had a lump in her neck for many years. There was a fairly large cystic adenoma in the right lower pole of the thyroid gland. Other small, firm adenomata could be palpated in both lobes. A faint bruit could be heard at the right superior pole. No palpable thrill was noted. The lungs were normal. The heart was considerably enlarged to both the right and the left side. There was marked precordial activity. A loud systolic murmur could be heard over the entire precordium. There were no diastolic murmurs. The blood pressure was 65-90. The heart rate was rapid (120 beats per minute) but the rhythm was regular. There was marked fine tremor of the extended fingers. There was a slight edema of the ankles.

Laboratory tests showed the urine to be of weak concentration (specific gravity 1.005) and to contain a marked trace of albumin (+++). No urinary casts were present. The blood sugar was 0.087 per cent. The red blood cell count was 4,160,000 and the white blood cell count was 4,600. The blood Wassermann test was negative. The basal metabolic rate averaged +63 per cent.

After 3 weeks of complete rest in bed, high caloric diet, and iodine therapy (potassium iodide grains 15, t.i.d.) the subjective symptoms completely disappeared. The basal metabolic rate remained slightly above normal but the pulse rate dropped to an average of 83 beats per minute.

On January 6, 1928, a resection of the right lobe of the thyroid gland was carried out. Numerous small colloid adenomata were present in the right lobe. The entire gland was well involuted by the administration of iodine. The postoperative course was uneventful. At the time of discharge from the hospital, there was no swelling of the ankles and no shortness of breath. The nervousness and irritability completely disappeared.

The patient remained free from her former symptoms for about one year. Financial distress and lack of work caused much worry to the patient. She again became nervous and irritable. In March, 1930, she was seen in the follow-up clinic because of the return of her former symptoms (Fig. 6). She had been losing weight rapidly and slight exertion caused complete fatigue. Physical examination showed a slight enlargement of the left lobe of the thyroid gland. The gland was soft and irregular in outline. There was a bruit at the left superior pole of the thyroid. No thrill was palpable. There was marked precordial activity. A loud systolic murmur could be heard at the base of the heart with a transmission of the murmur to the great vessels of the neck. The heart rate was about 100 beats per minute. The basal metabolism was again elevated. There was a fine tremor of the extended fingers. Because of the return of the toxic symptoms, the patient was referred to the hospital for subtotal thyroidectomy.

V THYROTOXICOSIS

(TOXIC NON-EXOPTHALMIC FORM)

Only one negro of our series presented evidence of moderate thyrotoxicosis without exophthalmos. This type of thyrotoxicosis is frequently found among the white people of the Great Lakes district. This case is presented in a separate group in order to emphasize the fact that all forms of

thyrotoxicosis can be found in the negro. The photograph (Fig. 7) was taken about 1 year after the thyroidectomy; consequently the original characteristic anxious expression was no longer present. There was no evidence of exophthalmos at any time during the course of his illness.

CASE 4. W. M. (Fig. 7), married, carpenter aged 43 years, native of Kentucky. This patient was referred from the medical service to the surgical service on February 5, 1927. A diagnosis of thyrotoxicosis was made, and the patient was given complete rest and iodine therapy for a period of 1 month before being transferred to the surgical service. On admission to the hospital he complained of marked nervousness, loss of weight, shortness of breath and swelling of the ankles. These symptoms came on gradually over a period of about 8 months during which time he had financial reverses and had great difficulty in supporting his family. Physical examination showed him to be a well developed but undernourished adult male negro. He was very restless and excitable. The face and hands were flushed and very warm. There was a slight enlargement of the thyroid gland. The gland was quite firm to palpation and no nodules could be felt. There was a faint bruit at the right superior pole of the thyroid gland. No thrill was present. The heart was slightly enlarged to the left. There was a loud systolic murmur at the base which was transmitted into the vessels of the neck. The heart rate averaged about 100 beats per minute. The lungs were normal. There was slight, fine tremor of the extended fingers. There was a very slight pitting edema of the ankles.

The laboratory tests showed the urine to be of normal concentration and free from albumin and sugar. The blood Wassermann test was negative. The red blood cell count was 4,597,000 and the white blood cell count was 7,600. The basal metabolic rate on admission was +4 per cent. The blood sugar was 0.3 per cent.

After 10 days of pre-operative preparation of complete rest in bed, high caloric diet, and Lugol's solution (m X t.i.d.) the subjective symptoms disappeared, the pulse rate became normal, and the basal metabolic rate was only slightly elevated.

Subtotal thyroidectomy was performed on February 26, 1927. The thyroid gland was found to be completely involuted. The postoperative course was uneventful. The patient was given Lugol's solution (m X t.i.d.) for about 1 week after the thyroidectomy.

Repeated follow-up examinations have shown the patient to be in excellent health and able to carry on his work as a carpenter without interruption. There has been no signs or symptoms of myocardial insufficiency since the thyroidectomy.

There seems to be no evidence that there is any racial immunity to thyrotoxicosis in the colored race. In the Great Lakes district where thyrotoxicosis is common among the white population we also find a relative proportion of all the variations of this syndrome in the negro. We have presented typical examples of each of these varieties of thyrotoxicosis in the negro to show that there is no difference in the severity of the disease or in the response to treatment between the negroes and the native white people. The reaction



Fig 1 Thyrotoxicosis (exophthalmic goiter)



Fig 4. Thyrotoxicosis (unilateral exophthalmos which appeared after thyroidectomy)



Fig 2 Thyrotoxicosis (juvenile exophthalmic goiter)



Fig 5 Thyrotoxicosis (toxic adenomatous goiter)



Fig 3 Thyrotoxicosis (unilateral exophthalmos present before operation)



Fig 6 Thyrotoxicosis (recurrent one year after lobectomy, Figure 5)

the surgical service on December 19, 1937 because of loss of weight, shortness of breath, nervousness, and palpitation. Examination showed her to be moderately well developed but very poorly nourished. She was very restless and excitable. Her face and hands were moist and very warm. There was a moderate prominence of both eyeballs. She stated that she had had a "lump" in her neck for many years. There was a fairly large cystic adenoma in the right lower pole of the thyroid gland. Other small, firm adenomata could be palpated in both lobes. A faint bruit could be heard at the right superior pole. No palpable thrill was noted. The lungs were normal. The heart was considerably enlarged to both the right and the left side. There was marked pericardial activity. A loud systolic murmur could be heard over the entire precordium. There were no diastolic murmurs. The blood pressure was 45-90. The heart rate was rapid (120 beats per minute), but the rhythm was regular. There was marked fine tremor of the extended fingers. There was slight edema of the ankles.

Laboratory tests showed the urine to be of weak concentration (specific gravity 1.01) and to contain a marked trace of albumin (+++). No urinary casts were present. The blood sugar was 0.087 per cent. The red blood cell count was 4,160,000 and the white blood cell count was 4,600. The blood Wassermann test was negative. The basal metabolic rate averaged +6.5 per cent.

After 5 weeks of complete rest in bed, high caloric diet, and iodine therapy (potassium iodide grains R, T.I.d.) the subjective symptoms completely disappeared. The basal metabolic rate remained slightly above normal but the pulse rate dropped to an average of 85 beats per minute.

On January 6, 1938, a resection of the right lobe of the thyroid gland was carried out. Numerous small colloid adenomata were present in the right lobe. The entire gland was well involuted by the administration of iodine. The postoperative course was uneventful. At the time of discharge from the hospital, there was no swelling of the ankles and no shortness of breath. The nervousness and irritability completely disappeared.

The patient remained free from her former symptoms for about one year. Financial distress and lack of work caused much worry to the patient. She again became nervous and irritable. In March, 1939, she was seen in the follow-up clinic because of the return of her former symptoms (Fig. 6). She had been losing weight rapidly and slight exertion caused complete fatigue. Physical examination showed slight enlargement of the left lobe of the thyroid gland. The gland was soft and irregular in outline. There was a bruit at the left superior pole of the thyroid. No thrill was palpable. There was marked pericardial activity. A loud systolic murmur could be heard at the base of the heart with a transudation of the murmur in the great vessels of the neck. The heart rate was about 110 beats per minute. The basal metabolism was again elevated. There was a fine tremor of the extended fingers. Because of the return of the toxic symptoms, the patient was referred into the hospital for subtotal thyroidectomy.

V. THYROTOXICOSIS (TOXIC NON-EXOPHTHALMIC GOITER)

Only one negro of our series presented evidence of moderate thyrotoxicosis without exophthalmos. This type of thyrotoxicosis is frequently found among the white people of the Great Lakes district. This case is presented in a separate group in order to emphasize the fact that all forms of

thyrotoxicosis can be found in the negro. The photograph (Fig. 7) was taken about 1 year after the thyroidectomy consequently the original characteristic anxious expression was no longer present. There was no evidence of exophthalmos at any time during the course of his illness.

Case 6. W. M. (Fig. 7) married, carpenter aged 43 years, native of Kentucky. This patient was referred from the medical service to the surgical service on February 5, 1937. A diagnosis of thyrotoxicosis was made, and the patient was given complete rest and iodine therapy for a period of 1 month before being transferred to the surgical service. On admission to the hospital he complained of marked nervousness, loss of weight, shortness of breath, and swelling of the ankles. These symptoms came on gradually over a period of about 3 months during which time he had financial reverses and had great difficulty in supporting his family. Physical examination showed him to be well developed but undernourished adult male negro. He was very restless and excitable. The face and hands were flushed and very warm. There was slight enlargement of the thyroid gland. The gland was quite firm to palpation and no nodules could be felt. There was a faint bruit at the right superior pole of the thyroid gland. No thrill was present. The heart was slightly enlarged to the left. There was a loud systolic murmur at the base which was transmitted into the axilla of the neck. The heart rate averaged about 100 beats per minute. The lungs were normal. There was a slight, fine tremor of the extended fingers. There was very slight pitting edema of the ankles.

The laboratory tests showed the urine to be of normal concentration and free from albumin and sugar. The blood Wassermann test was negative. The red blood cell count was 4,597,000 and the white blood cell count was 7,600. The basal metabolic rate on admission was +41 per cent; the blood sugar was 0.1 per cent.

After 10 days of pre-operative preparation of complete rest in bed, high caloric diet, and Lugol's solution (m V, T.I.d.) the subjective symptoms disappeared, the pulse rate became normal, and the basal metabolic rate was only slightly elevated.

Subtotal thyroidectomy was performed on February 26, 1937. The thyroid gland was found to be completely involuted. The postoperative course was uneventful. The patient was given Lugol's solution (m V, T.I.d.) for about 1 week after the thyroidectomy.

Repeated follow-up examinations have shown the patient to be in excellent health and able to carry on his work as carpenter without interruption. There has been no signs or symptoms of myocardial insufficiency since the thyroidectomy.

There seems to be no evidence that there is any racial immunity to thyrotoxicosis in the colored race. In the Great Lakes district where thyrotoxicosis is common among the white population, we also find a relative proportion of all the varieties of this syndrome in the negro. We have presented typical examples of each of these varieties of thyrotoxicosis in the negro to show that there is no difference in the severity of the disease or in the response to treatment between the negroes and the native white people. The reaction

VASCULAR ANOMALIES OF THE EXTREMITIES

REPORT OF FIVE CASES¹

G DE TAKATS, M D, M S, F A C S, CHICAGO

From the Peripheral Circulatory Clinic of the Department of Surgery, Northwestern University Medical School

VASCULAR anomalies occur, when some part of the primitive vascular network is retained or transformed to a more adult arrangement, without undergoing definite stages of development (Baader, 1866) Woollard, in careful studies of vascular development in the forelimb of the pig, recognized three stages in the formation of an individual arterial tube, namely (1) the stage of capillary network, (2) the stage characterized by enlarged tubes showing island formation, coalescence, and tendency to fuse (retiform stage), (3) the formation of a definite stem, with disappearance of other vascular units

The clinical nomenclature of vascular malformations and growths is confusing Borst has repeatedly emphasized that true angiomas must show evidence of endothelial proliferation and formation of syncytial network Most of the so called angiomas, however, are only angiectasias, that is dilatation and lengthening of arteries, veins, or both They represent developmental anomalies, and their growth may be readily explained by a continuous filling from the arterial system, with which they may be connected The capillary angiomas of the skin, vascular naevi, and the cavernous hæmangiomas of the liver are typical examples of developmental anomalies and are not true tumors in the histological sense of the word

The racemose angioma, occurring on the head, lower and upper extremities, has obviously a congenital anlage, but a transformation of a simple angioma into a racemose angioma by trauma is rarely but definitely established (Sonntag) These tumors are described as consisting of a mass of small and finest arteries, less elastic, and gaping in cross section A proximal nutrient artery is dilated, while distally only a short segment is involved Later a dilatation of veins appears and communications are established between veins and arteries Pregnancy and muscular exertion accelerate their growth

The diffuse phlebectasia and the diffuse phlebectasia is described by Sonntag in detail The dilatation is limited to existing vessels and a new formation of vessels cannot be demonstrated Their origin is congenital but they sometimes become manifest at puberty or even later Communications between veins and arteries are possible but are supposed to be secondary

Congenital arteriovenous communications have been described in detail by Callander and Pemberton and Saint There may be a few or a large number of communications between arteries and veins, and the oxygenation of the venous blood can be definitely demonstrated Brown pointed out that the color of the mixed venous blood when compared with a normal venous blood is usually sufficient to establish a diagnosis of arteriovenous communication

In recent years a great deal of experimental work and clinical observations have been made on the physiology of arteriovenous fistulæ, by Halsted, Matas, Reid, and Holman While experimental fistulæ imitate conditions which are present in traumatic or syphilitic aneurisms with large communications, the findings of these authors are also very important for the understanding of the multiple congenital arteriovenous fistulæ The decrease in peripheral resistance, increase in venous pressure, increased volume of blood, and increased heart action are briefly the general cardiovascular effects of such communications Naturally, the smaller and less numerous the openings are, the less noticeable the systemic changes are going to be Holman showed that the presence and intensity of the thrill is dependent on a free flow of blood to the heart from the fistula Contrary to most American workers, Lewis and Drury believed that there is no increase in the general venous pressure in arteriovenous aneurisms and that the dilatation of the heart is due to a faulty circulation in the coronaries

The differential diagnosis of angioma simplex, cavernous and racemose angioma, diffuse phlebectasia, and congenital arteriovenous fistula is sometimes impossible Transitions from one group to the other are frequent In studying the cases described in the literature and after having observed the 5 cases to be discussed, it seems fair to assume as a working hypothesis that (1) none of these vascular tumors are true growths and are all due to faulty development and that (2) the variations encountered are due to the stage of vascular development in which the aberration from the normal occurred Thus the capillary angiomas (vascular naevi) are localized remnants of the primitive capillary net. They remain harmless birthmarks until a sudden connection with the general circulation

¹Since this article was written 3 additional cases have been studied Two of these came to operation with good functional results One patient received injections of a sclerosing solution with partial relief



Fig 7 Thyrotoxicosis (toxic non-exophthalmic goiter)

to iodine and subtotal thyroidectomy is identical in the two races. It has been repeatedly pointed out by Allen Graham that there is no essential difference between the response to iodine in cases of exophthalmic goiter and in cases of toxic adenoma of the thyroid gland. Increased basal metabolic rate and other evidence of "thyrotoxicosis," together with hypertrophy and hyperplasia of the thyroid of any degree, are regarded by Graham and Cutler as sufficient indication for the administration of iodine, irrespective of the presence or absence of adenomata. Harris states that the administration of iodine to negroes with toxic adenoma of the thyroid is harmful and he states that one of his patients was made worse by such therapy. In our entire series of toxic adenomatous goiter in both the white and the colored races we have had uniform improvement in all subjective symptoms after the administration of iodine in the proper amounts.

Sudden psychic shock, financial worries, and domestic difficulties seem to play an important part in precipitating this symptom complex in the negroes as well as in native white people. For this reason we have taken special care to study the living conditions of these patients and through the co-operation of the social service department, we have been able to get most of these patients back to a normal self-supporting life after their period of convalescence.

SUMMARY

1. Thyrotoxicosis is not an uncommon disease in the negro.
2. All varieties of the symptom complex have been observed in the negro.
3. The reaction to iodine therapy and subtotal thyroidectomy is essentially the same as in the white race.
4. There is no evidence that iodine therapy is contra-indicated in cases of toxic adenomatous goiter in the negro.
5. Psychic shock, financial worries, and domestic difficulties seem to play a part in precipitating this symptom complex in the negro.
6. Removal of such irritating factors should be an essential part of the postoperative treatment of thyrotoxicosis in the negro.

NOTE.—The author wishes to thank Miss Mary Post, of the social service department of the Lakeside Hospital, for the excellent co-operation she has given us during the study of these patients.

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Fig 5 Case 1 Section taken from a fingertip shows a thrombotic vein with marked hypertrophy of the wall. The vein is arterIALIZED because of the high pressure of the arteriovenous blood. There is no evidence of intimal proliferation. The veins of the fingers are simply dilated because of the communication of artery and vein in the palmar arch. Repeated diagnosis of hæmangioma of the hand was made in this case. $\times 85$

eration, but if the "angioma" is due to anomalous communications, the feeders are not affected. On the extremities the extent and depth in which these vessels are found makes exclusive treatment of radium of dubious value.

The early surgery of these lesions consisted of simple proximal ligations of arteries (Sonntag). Unfortunately this is not sufficient. In Case 1 the radial artery had been tied, later venous dilatations were excised, and finally I had to tie the ulnar artery and excise a congenital aneurism in the palmar arch. If the anomaly consists of a single or few abnormal communications, they are simply ligated and thus the perverted physiology of circulation is restored to normal. Such fistulæ have been seen on the neck, between common carotid and jugular veins. On the extremities the communications are usually very extensive and the resulting proximal and distal dilatations may transform the limb into a spongy mass, which invades the muscle and may even be present in the bone marrow. The object of the very radical operations must be to excise the whole vascular tumor and yet leave enough circulation to prevent gangrene. Usually an intensive collateral circulation develops around the arteriovenous fistulæ.

The circulatory embarrassment distal to the fistulæ manifests itself in a cyanosis of the acra. Thus in Case 3 the fourth and fifth toes were



Fig 7 Case 2 Embedded in loose connective tissue there are a number of blood vessels with a great variation of structure. The intima is unusually thick, muscle is present, but elastic tissue is difficult to identify. The lumina of both the thick walled and thin walled veins are frequently subdivided into compartments by thin septa. $\times 125$

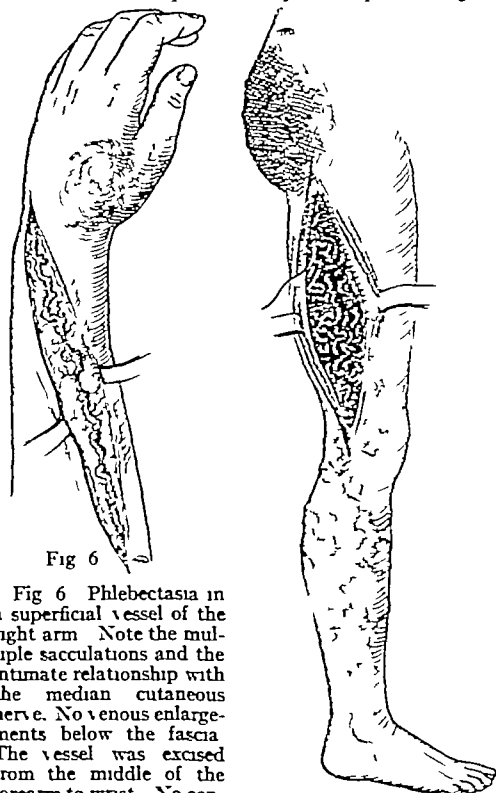


Fig 6

Fig 6 Phlebectasia in a superficial vessel of the right arm. Note the multiple sacculations and the intimate relationship with the median cutaneous nerve. No venous enlargements below the fascia. The vessel was excised from the middle of the forearm to wrist. No connection with the arterial tree.

Fig 8

Fig 8 Case 3 A large spongy mass of dilated vessels extended from the skin down to the deep fascia and into the muscles. The edges of the muscle fascia had to be whipped with interlacing sutures to control the bleeding. The whole mass was removed.

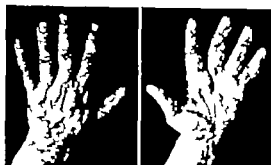


Fig. 2. left. Dorsal aspect of left hand, Mrs. P. T. K. There is considerable dilatation of the normal veins, but no abnormal venous masses.

Fig. 3. Volar aspect of left hand, Mrs. P. T. K. Note the venous masses on the fingertips, which were very painful and became inflamed repeatedly.

starts feeding them with blood, in which case progressive cavernous dilatations develop which grow destructively owing to the continuously increased pressure. Trauma has definitely been established to start a simple angioma to expansion.

The diffuse phlebectasia and the congenital arteriovenous communications may take origin in the second, retiform stage of development. A number of parallel vascular tubes which have not fused sufficiently and are connected with multiple communications, represent a developmental arrest in the second stage. Some of these cases only show a few tiny communications and their surgical attack is simple. Other patients show such innumerable and inapproachable communications, that they are practically inoperable, and lead to a progressive gangrene and amputation.



Fig. 3. Sketch of findings at operation, Mrs. P. T. K. The ulnar artery was exposed. It was tortuous, sclerotic, and entered into a convoluted mass of veins, which pulsated. The mass extended from the wrist into the deep palmar arch, was freed and Carrel clamps were applied both distally and proximally.



Fig. 4. Good function of left hand, Mrs. P. T. K. years after operation. The right hand is shown for comparison.

It is also conceivable that the vascular development reaches the third stage, namely that of definite stem formation, but that one of the primitive vessels has persisted and presents an anomalous primitive trunk with a histological structure, which does not correspond to either the histology of an artery or that of a vein. Case 5 belongs to this group.

The physiological effects of such vascular anomalies have interested the experimenter, but few studies are available on clinical cases. It is attempted here to give a composite picture of the conditions observed in the five patients although not all studies have been made on all cases. The heart, the changes in pulse, blood pressure, the color and oxygen content of blood in the dilated vessels, and the blood volume were studied. Finally in one case, an attempt was made to visualize a feeding artery of a large gluteal angioma with X-ray after injecting an opaque substance into the dilated vessels.

The treatment in all the 5 cases was surgical. Conservative treatment with elevation, elastic compression is obsolete. Injection of absolute alcohol, 2 to 4 cubic centimeters every third day was tried in 1 case (Case 5) without success. In another patient, however, after radical excision was performed on the thigh, the remaining dilatations below the knee could be readily obliterated with 10 per cent quinine-urethane solution, as used in the treatment of varicose veins. The arterial inflow of blood, however, particularly if multiple communications exist, will exclude any permanent obliteration by injections, unless the chief feeders are ligated.

Radium treatment of these vascular growths is successful on the face, tongue and larynx if one is dealing with circumscribed vascular naevi (Simpson). I have used radium on angiomata of the orbit as a preliminary step to radical excision. It shrinks the vessels, reduces hemorrhage at op-

In more recent case massive injections of radium morphine into large anastomosis in the neck, relieved the symptoms, of lower extremity.

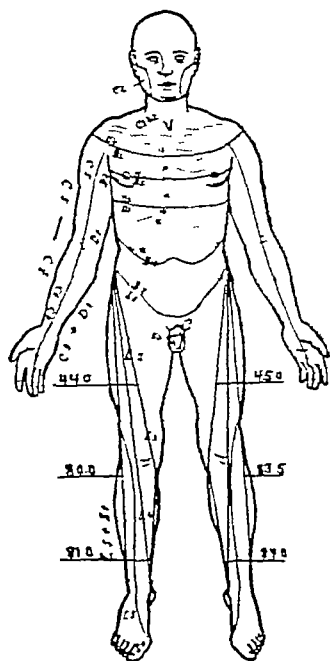


Fig 11 Measurements of the lower extremities in Case 4, indicating a marked hemihypertrophy of the left limb. There is a maximum difference of 3 centimeters measured between anterior superior spine and inner ankle, indicating that the increased blood supply was operating before the closure of the epiphyseal line.

teriovenous anastomosis. This sign described by Branham, is usually called after this author (Reid), but as pointed out by Dean Lewis has been described many years ago by Nicoladoni. It was present only in our first case, when a great volume of blood was sidetracked.

The hemihypertrophy of the affected extremity described by many authors in conjunction with congenital arteriovenous fistula (Harris, Horton) was very marked in our fourth case, when the increased blood flow was operating before the closure of the epiphyseal line. A marked sympathetic disturbance was observed in Case 2—there was no difference in length, however.

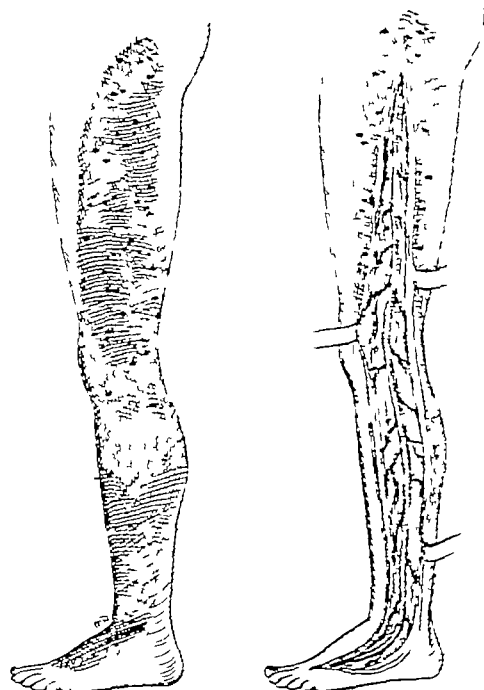


Fig 12 Operative findings in Case 4. Note the large anomalous vessel below the superficial fascia, which is exposed from thigh to dorsum of the foot. This is a composite diagram of three successive operations. The shaded area represents the extent of the cutaneous birthmark, while the small black dots illustrate the distribution of multiple capillary angiomas, which bled readily.

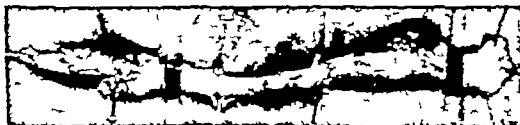


Fig 13 A 13 centimeter segment of a blood vessel, the diameter of which is from 6 to 8 millimeters. The thickness of the wall was from 1 to 2 millimeters. The lumen was almost completely obliterated by a blood clot.

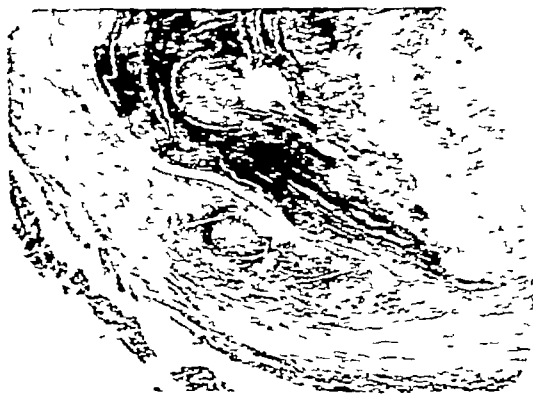


Fig 14. Photomicrograph of the anomalous vessel in Case 4. A segment of the large vessel shows an irregularly thickened wall, which has the thickness of an artery, but is very poorly differentiated into layers. The media adjacent to the intima contains a large number of longitudinal muscle fibers, which, according to Maximow, occurs in primitive, non-differentiated vessels. No elastic membrane is seen. The lumen is almost completely occluded by a large thrombus, which shows organization in places. X256.



Fig. 9. Visualization of anomalous blood vessels with 30 per cent croscollast. Between two tommiquants, 30 cubic centimeters of the opaque solution was injected and a soft X-ray exposure was made within 0.0 seconds. Note a large vessel which could later be injected and caused marked collapse of the venous mass in the gluteal region.

cyanotic and in spite of three extremely radical operations remained so. When the arterial blood follows the least resistance in to the veins, blood is shunted from the capillary bed and thus the tips of the extremities are poorly nourished. Together with the cyanosis a drop in surface temperature takes place, also indicating the poor inflow of blood. This may progress into a gangrene, requiring amputation. In Sonntag's series 4 of the 13 cases of "genuine diffuse phleboarteriectasia" ended in amputation. A very disturbing complication is the appearance of migratory attack of phlebitis in the distal venous dilatations. This was observed in Case 1 and led to a great deal of suffering. It has not recurred since the operation.

Another serious complication is the appearance of multiple millary capillary aneurysms as small dark red spots on the skin. In the fourth patient, these millary aneurysms would bleed like a fountain on the slightest provocation. Heavy doses of X-ray were used to check them, as they had not subsided after the excision of the abnormal vessel.

Owing to the increased venous pressure, these limbs are oedematous and painful when in the dependent position. The first patient had her arm in a sling and kept her arm on a cushion when



Fig. 10. Photomicrograph containing a large number of blood channels varying from tiny capillaries to large arteries. The latter have a differentiated wall, on which smooth can not be identified. They show irregular folds as an evidence of unusual and abnormal distention. Some hypertrophy of the intima but no real proliferation. X 445.

she rode in a car. Bandaging gave her and another patient of this series some relief. In some patients elephantiasis-like pictures develop with a sclerosis of the connective tissue, which is hardly a reversible process. This all adds to the difficulty of surgical management.

Proximal to the fistula, a dilatation of arteries and veins occurs. The thrill at the site of fistula, which is so characteristic in the traumatic arteriovenous communications, was absent in this series, because the congenital communications are too small to give a thrill. Theoretically, the blood pressure should be lower on the affected extremity as a part of the peripheral resistance is excluded. In the first patient the systolic pressure was sixteen points lower and the diastolic ten points. In the fourth patient the systolic pressures were equal, but the diastolic pressure was ten points lower. Oscillometric readings taken in the two patients in whom the lower extremities were affected, showed increased oscillations above—diminished oscillations below the fistula. Obviously the pulse volume is greater above the fistula, but only a part of it reaches the distal parts. The effort to compensate for this loss was studied experimentally by Holman. A definite increase in blood volume takes place which in turn influences the minute volume of the heart and overloads it. In the one patient in whom blood volume was studied there was a marked decrease after the operation. It is well known that all aneurysms lead to dilatation of the heart. In our first case there was a definite enlargement of the heart with an accentuated second aortic tone. However this was probably due to a co-existing hypertension on an arteriosclerotic basis. The other patients showed no heart changes.

Interesting is the bradycardic phenomenon, occurring when pressure is exerted at the site of ar

history of trauma, the impression was rather that multiple congenital communications existed. No bruit was present. Pressure on the wrist, however, decreased the pulse from 86 to 60.

On July 19, 1928, under brachial plexus block with 20 cubic centimeters of 2 per cent procaine, an old healed scar in the elbow was first excised. The cubital artery and veins were exposed and were found normal. An old phlebotic induration above the upper part of the ulna was excised. The ulnar artery was exposed and was followed down into the deep palmar arch. The artery was elongated, tortuous, sclerotic, and formed one inseparable mass with a convolute mass of veins which pulsed and carried visibly arterial blood (Fig. 3). This mass extended from the wrist into the deep palmar arch and was freed in a length of 8 centimeters. After applying Carrel clamps, both distally and proximally, the blood supply of the hand still seemed satisfactory. The whole mass then was excised after ligation of small communicating vessels with Carrel silk. A small rubber tube was inserted at the most distal point. The wound healed without any reaction except for an iodine dermatitis, which subsided under mentholated zinc oxide paste. On March 2, 1928, under finger block, enlarged venous dilatations on the volar surface of the thumb, fourth and fifth fingers were excised. They bled profusely an oxygenated, arterial blood which contained phlebotitis. Their nutrient arteries were tied with No. 000 catgut and dermal sutures united the skin.

Following the operation there was no sign of impaired circulation. The hand was warm, pink, and no edema developed. Gradually after the healing of the incisions, massage was started. The hand had not been in use for almost 15 years. At the present time, 3 years after the operation, patient uses her hand freely—can play golf (Fig. 4). There is a hypertrophic scar at the wrist and occasionally a feeling of fullness is still present. Patient lives in the East and is seen only infrequently. She reports, however, a continuous improvement in her hand but that the hypertension seems to give her more trouble.

Histological findings. The entire specimen, as excised, could unfortunately not be preserved as the histological work necessitated cross sections of the mass. In the sections, several veins with thickened, irregular sclerotic walls were seen. One vein contained a small, hard white nodule, with a calcified degenerated center. In one place there was an organized and partially healed thrombus. At another a small, more recent thrombus. The structure of these vessels nowhere suggested an artery (Fig. 5).

In another section, however, vein and artery lay closely side by side plastered to each other, but no communication at least at the level of the sections could be detected.

Summary. A 58 year old patient, who gave the history of progressive vascular dilatations of the left arm and hand since a trauma at the age of 12, has several attacks of phlebitis, and an increasing disability of the left hand. Two previous operations were performed, but the fistulae were not recognized. A radical excision of the ulnar artery with fistulous openings did not impair the circulation of the arm, although the radial artery had been previously tied. A great deal of relief followed the operation, and no reappearance of further dilatations is present after 3 years. Patient, who has not used the arm for 15 years, now plays golf.

CASE 2. H. L., aged 21 years, single mechanic was first seen at the Northwestern University Clinic, complaining

of a progressive dilatation of the veins on the right wrist and forearm, with aching pain when the arm is used. He had noticed "varicosities" about 8 years ago, at the age of 13. The veins were first enlarged at the wrist, but gradually an involvement of the radial side of the forearm took place. After the arm was exercised a dull, aching pain occurred, which prevented him from working. For the last 3 years patient also has noticed a marked flushing of the right half of the face and increased perspiration.

Outside of occasional headaches, patient's inventory by systems is negative. He had had measles, mumps, and whooping cough in childhood. There is no history of cardiac disease or vascular anomaly in his family.

On physical examination (only positive findings recorded here) there was found a chronic inflammation of tonsils and pharynx. There was a diffuse enlargement of the thyroid gland, rather soft and not pulsating. The pulse was 96, blood pressure 120-80. On the right upper extremity a dilated vein was seen on the dorsal surface of the forearm from the tuberosity of the radius to the middle of the forearm. In the dependent position, the filling of the vein was more marked. It showed several saccular enlargements and small ramifications. There was no pulsation in this vessel. The blood pressure in the two arms was equal.

Of the laboratory findings, the red cell count was 3,670,000, the white count 7,900, the hemoglobin 75 per cent. The urine was normal. Wassermann and Kahn reactions were negative. The oxygen content of the blood taken from the dilated vessel was 18.2 per cent, it was higher than that of the cubital vein on the other side, which was 17.1 per cent.

On November 2, 1929, under brachial plexus block with 20 cubic centimeters of 2 per cent novocain with adrenalin, an incision was made along the radial side of the right arm from the middle of the forearm to the wrist. A large vessel was exposed, showing sacculations (Fig. 6). There was an intimate relationship with the median cutaneous nerve. There seemed to be no connection between the venous dilatations and the arterial system. The vein was followed to the level of the wrist, where it appeared to be normal. There was no enlargement of the deep veins, as ascertained by a slit in the fascia. The vessel was ligated with fine catgut, proximally and distally. The skin was sutured with continuous dermal suture. Postoperative diagnosis: congenital phlebectasia of right arm.

The postoperative course was uneventful. The pathological report was made by Dr. S. Vaughan (Fig. 7). Grossly the specimen consists of an elongated mass of loose connective tissue, containing conspicuous blood vessels which have an average diameter of about 4 millimeters. At irregular intervals saccular dilatations are observed, which attain a maximum diameter of about 7 millimeters. Microscopically, the loose connective tissue is found to contain, besides a quantity of fat, a large number of blood vessels of considerable size. These show a great variation of structure. Most of them have rather thick, but irregular, walls. Muscle is present in them but there is an excess of connective tissue. At the level of the saccular dilatations, the wall is greatly thinned. The linings of the vessels are composed of endothelial cells, which are rather larger and thicker than normal. Elastic tissue in the walls is difficult to identify. The lumina of both the thick and thin walled vessels are frequently subdivided into compartments by thin septa, which are continuous with the walls.

Summary. A young man of 21 complained of progressive dilatations of the veins on the right wrist and forearm, with aching pain when the arm was used. The enlargements were first noticed at the age of 13. There was also a marked

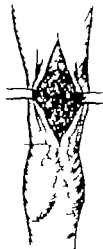


Fig. 5. Operative findings in Case 5. A spongy vascular mass was exposed in the left popliteal fossa. It had no relationship to the internal saphenous vein or to the deeper vascular structures and was entirely superficial. The mass did not pulsate but the color of the blood was bright red, not venous.



Fig. 16. Section of the vascular mass in Case 5. A large number of blood vessels are seen, with a hypertrophic intimal lining. It represents a primitive vascular network, but no evidence of angoma formation.

CASE REPORTS

CASE 1. Mrs. P. T. K., aged 58 years, referred by Dr. W. H. Stearns, was admitted to the Evanson Hospital on July 7, 1928 (Hosp. N. 74), complaining of pain, throbbing, and repeated attacks of phlebitis in the left arm. She also stated to have knowledge of her high blood pressure and mild diabetes.

At the age of 3 or 4 she fell on her left arm from a haystack but does not think her arm was broken, as the function of the arm was not impaired. However she thinks that dilated veins began to appear from this time. The veins would enlarge with every pregnancy. There were four deliveries, the first of which was normal. At the second three twin girls were born with instrumentation, followed by laceration of perineum and postpartum infection. The third time a pained baby was delivered with forceps and a severe postpartum infection developed.

Since 1912, recurrent attacks of phlebitis occurred in the left arm, the first attack followed an appendectomy and drainage of gall bladder. The latter was undertaken because of severe attacks of vertigo lasting from 10 to 12 hours. In 1913, the gall bladder and ovaries were removed, a cystoscopy performed for possible kidney stones, the tonsils removed, and nine teeth extracted because of periodontitis in the left arm. In 1918, another laparotomy was done. A Lane's clamp was forced and the uterus was removed. In 1919, an operation was performed on her left arm and hand. So far as can be ascertained, at the first operation the radial artery was tied and some of the venous distalities excised. At the second operation performed by another surgeon, in 1922, with the diagnosis of hemangioma, multiple excisions of venous masses were made. The scars from these incisions caused a lot of pain. In 1926 a floating kidney was treated with supportive measures and the ureters were dilated by Dr. B. L. Corbois. This treatment gave the patient complete relief from her back pain. In 1927, diabetes was discovered and her diet regulated by Dr. Woodruff. On basal diet of 77 grams of carbonyl

drate, 5 grams of protein, and 100 grams of fat, a glucose value of 8 and total calories of 235 also became regular. The pain in her arm and the occipital headaches and dizziness continued.

Since 1910, patient has also been subject to repeated "nervous break downs" with melancholy and has been under the supervision of Dr. W. H. Stearns, who referred the patient for study of the vascular condition of her arm.

The physical examination (only pathological findings recorded here) revealed: deafness of the right ear; distant heart tones without any murmurs, second aortic tone short and accentuated. Blood pressure on the right arm 50-90, on the left 34-84. A smooth palpable mass in the right upper quadrant could be replaced into the lumbar region (floating kidney). The left arm showed dilated compressible masses: 1 the elbow, on the outer side of the flexor surface of the arm, and on the fingertips. The dorsal surface of the hand showed marked dilated veins but no venous masses (Figs. 1 and 2). There were painful hypertrophic scars at the elbow at the wrist above the radial artery and on the tips of the fingers. The fifth finger showed a partial ankylosis to the last phalangeal joint.

The arm showed definite rubor in the dependent position, and was kept in a sling because of pain when hanging down. There was no pallor on left at the radial artery. The ulnar artery pulsated well. There was no thrill heard or palpated over any of the venous distalities. A number of small phlebitides were palpable as a result of the previous attack of phlebitis. The nerves of the arm were spared; the whole arm seemed atrophic as compared with the right side. At the middle of the forearm the difference in circumference was two-tenths of an inch. The grasp of the left hand was feeble, but motions were not limited in any joint except in the phalangeal joint of the fifth finger.

The Wassermann reaction was negative. The arm was free of pathological elements. The blood sugar was 100 mgms per hundred cubic centimeters. X-ray examination revealed evidence of osteo-arthritis of the phalanges in both hands. There was a good deal of thickening of the soft tissues of the arm, forearm, and hand, and definite deposits due to old phlebotic calcifications.

A gas analysis of blood from one of the enlarged masses revealed: carbon dioxide content of 33.54 volume per cent, an oxygen content of 9.5 volume per cent, with an oxygen capacity of 20.85 volume per cent (Albee P. J. Crittenton). This method of analysis was used.

On the basis of the above gas analysis, the diagnosis of an arteriovenous communication was certain. In spite of the

began to have more pain, and the growth increased in size. A radical excision of the growth was done on the thigh. The scrotal and gluteal involvement was not attacked. The veins in the popliteal fossa and on the calf were injected with quinine urethane. The progress of the disease seems to be arrested although only 7 months have elapsed since the operation.

CASE 4. Agnes D., 16 years old, office clerk was admitted from Northwestern University Clinic to Wesley Memorial Hospital on July 28, 1929, complaining of swollen veins in the left leg and repeated hemorrhages from rupturing small vessels. Patient first noticed a swollen vessel on the lateral surface of the left calf at the age of 10 years. But ever since birth there has been a large port-wine birthmark extending from the thigh to the ankle on the outer aspect of the limb. There was no history of any vascular anomaly in her family. At the age of 13 she was taken to Cook County Hospital. She was given several treatments of X-ray after which the dark red birthmark faded but the dilated vessels were not affected. Later radium was applied without any noticeable effect. On examination a well grown, healthy young girl of about 15 years of age showed a slightly enlarged heart with a second pulmonic tone accentuated. There was a marked systolic murmur at the apex. The right lower extremity seemed perfectly normal. The left lower extremity was definitely abnormal. A large, somewhat faded port-wine stain extended from the thigh through the lateral and posterior aspect of the calf to the ankle. The limb was studded with small capillary dilatations and also larger vessels, which protruded and greatly enlarged on standing. The limb was 3 centimeters longer than its fellow, the lengthening being present between the knee and ankle (Fig. 11).

The laboratory reports revealed 4,600,000 red cells and 75 per cent hemoglobin, a moderate secondary anemia. Urine analysis was negative. An X-ray film taken of both tibias revealed no pathological findings. The Wassermann and Kahn reactions were negative. Patient was a Type II.

On July 31, 1929, under nitrous oxide and ether anesthesia a long incision was made on the lateral aspect of the thigh. There was profuse bleeding from small skin vessels. A very large, anomalous vessel was encountered below the superficial fascia. It was thick, did not seem to pulsate but had the size of about the common iliac artery, running parallel to the long axis of the limb (Fig. 12). It gave numerous branches medially and laterally which were clamped and tied. About an hour after the operation was started and the patient's pulse became rapid and weak. She had obviously lost too much blood. The operation was rapidly completed, the incision terminating at the knee. Camphor oil was administered in the operating room. Dextrose and salt solution were given intravenously and under the skin. The red cells had dropped to 2,700,000 the next day with a hemoglobin of 61 per cent. The healing of the wound was uneventful. On a high caloric diet with 200 grams of liver and 4 grams of ammonium ferri citrate, her red count rose to 4,510,000 on August 19, 1931, with 75 per cent hemoglobin. She was discharged with a completely healed incision and an elastic bandage. It was thought of continuing the operation at a later period.

From September 1, 1929, to January 5, 1931, patient visited the Northwestern University Clinic every 2 or 3 weeks. The function of the leg was much improved. Repeated attempts were made to obliterate the venous dilatations on the dorsum of the foot and ankle by strongly irritating solutions such as 10 per cent quinine, 30 per cent

sodium chloride, and 5 per cent alcohol. It was ~~unsuccessful~~ however, to obtain any obliteration with these solutions because of the presence of the strong back pressure of the above.

On January 5, 1931, patient was admitted to Wesley Memorial Hospital with a profuse hemorrhage from one of the ruptured capillary aneurysms at knee level. The bleeding was easily controlled by compression. On the following day, under nitrous oxide anesthesia, the procedure was continued distally from the knee to the ankle, the bleeding capillary aneurysm being excised. Just below the superficial fascia, the same anomalous vessel was encountered, in close proximity to the common peroneal nerve. The vessel had numerous branches which extended under the fascia into the muscles. It apparently carried non-pulsating, cyanotic blood. No communication with the arterial tree was found at this level. About 194 mm after the beginning of the operation, patient again went into shock and the wound was rapidly closed with interrupted silkworm gut sutures. The blood pressure dropped to 60/00. The head end of the bed was elevated, 500 cubic centimeters of 6 per cent gum acacia solution was given intravenously. At the completion of the incision, the blood pressure rose to 120/60. Patient had a chill lasting 5 minutes immediately after the incision. She recovered rapidly from the shock. On the fourth day following the operation a very painful, urticaria developed, which faded but recurred on the eighth day. It was accompanied by a rise of temperature and interpreted as an anaphylactic reaction to gum acacia. On January 27, 1931, patient received an X-ray of the foot and was discharged for ambulatory treatment.

At the third admission on March 27, 1931, patient complained chiefly of an increasing swelling of the ankle and dilatation of blood vessels on the dorsum of the foot. The tip of the first toe was cyanotic, the surface temperature being only 25 degrees C. There was also motor and sensory paralysis of the peroneal nerve, with increased heat over the anesthetic area. As the rotation of the foot was not very good, it was hoped that with the next operation the terminal portion of the anomalous vessel could be removed. On March 29, 1931, the vessel was again exposed at the external malleolus and a curved incision was made over the dorsum of the foot. A skin flap was lifted up with a lateral pedicle. The vessel was again identified just below the tense lateral ligament and the latter was divided. Many small vessels branching from the large vessel, were tied with fine catgut. A small exploratory incision was also made on the medial side of the foot but no further vessels were found there. The lateral ligament of the ankle joint was carefully repaired and the skin was united with interrupted silkworm gut.

Eleven days later, under spinal anesthesia, an incision was made in the popliteal fossa, slightly lateral to the median line. There was considerable bleeding from the subcutaneous tissue. The scar from previous operations was very heavy. The posterior tibial nerve was exposed and followed distally. It was found to be intact and non-repulsive adherent to the scar. The anterior tibial nerve (peroneal nerve) was imbedded in heavy scar tissue from which it was freed. A segment of 3 1/2 inches had undergone a complete fibrosis, the nerve bundles on cross section were hardly visible. In all probability, this part of the nerve was caught in ligature or it was the result of an organized aneurysm. This part of the nerve was dissected free and well mobilized proximally and distally. Stumps of the proximal and distal stump were taken until the cross section of the nerve looked normal. This left a large gap between the stumps, which could be bridged only by a 90 degree flexion of the knee. As the destruction of the nerve had occurred at the division into the superficial and deep branch, the two usual

flushing of the right half of the face and increased perspiration. An anomalous vessel, showing an abnormal histological picture was excised and patient's complaints subsided. No further enlargements are present after 3 years.

CASE 2. Joseph D. F., aged 30 years, was referred by Dr. Paul B. Macgregor. He was admitted to Wesley Memorial Hospital on September 9, 1930, complaining of inability to work because of progressive muscular enlargements of his right leg and thigh. He first noticed a discoloration of the lateral surface of the right leg and thigh at the age of 5 years. This remained fairly stationary until 6 years ago, when, at the age of 11 there was a rapid development of round, bluish spot in the right popliteal fossa. Within a year the mass developed to the size of an orange and became very painful. Five years ago the growth and a portion of the extension on the thigh and lower leg were removed by a physician in Kansas, Wis. Two years ago he began to have pain again on the lateral surface of the right leg and thigh and was told to wear a bandage. This gave him relief until about 4 months ago when a persistent aching pain developed when he walked. The pain could be relieved by sitting down or lying down.

A year ago a red spot developed on the inner side of the right thigh. This also gradually increased up to 3 centimeters in diameter.

Past history was negative except for tonsillitis at the age of 10 years. There was no history of any vascular anomaly in the family. Physical examination (only positive findings) revealed a bluish discoloration of the right half of the scrotum, about 3 centimeters in diameter and slightly raised. The testicles were in the scrotum. The bluish discoloration disappeared on pressure and was obviously due to dilatation of the subcutaneous vessels of the skin. There was the same irregular bluish discoloration of the skin vessels extending from the superior border of the gluteus maximus muscle down to the middle of the thigh on the external side. This was not capillary telangiectasia, but visible dilatations of small vessels, possibly venules. There was linear scar about 35 centimeters long on the lateral surface of the thigh and lower leg. There were extensive venous dilatations distal to the knee extending down to the ankle. The whole picture corresponded to a so called hemangioma cavernosum.

The reflexes were normal.

First operation was performed on September 29, 1930, under spinal anesthesia with 3 cubic centimeters of epinephrine and 100 milligrams of quinine. An incision was made about 15 centimeters long on the lateral surface of the thigh down to the knee joint. A large spongy mass of dilated vessels extended from the skin down to the deep fascia and even below that into the muscles. A generous oval incision was made into the muscle fascia and the edges were immediately whipped with locking hemostatic sutures (Fig. 4). Thus as much of the vascular mass as possible was removed. The skin flaps had to be retracted considerably and were very thin when sutured with interrupted silk suture. A great aneurysm aneurysm was used to control the bleeding.

The patient was in good condition following the operation but on the eleventh day a rupture of the suture line occurred. The edges became necrotic, and the suture cut through. Also as monocytes have been had formed under the skin, the pressure of which may have helped to burst the suture line. The hematoma was evacuated. No bleeding points were found. The edges of the wound were trimmed and resutured. Gauze rolls were returned over the incision to act as pressure pads.

On September 15, 1930, 3 days after the secondary suture, there was definite evidence of an anoxic infection. There was a peculiar sweetish odor of the surrounding tissues, and definite gas bubbles in the discharge. The gas formation was noted a few days after the first operation but did not seem to blow up until the resuturing of the wound. Treatment with hydrogen peroxide and antiseptic gas progress suture was ordered.

As the patient was running a septic temperature and had developed a marked anemia (3,500,000 red blood cells, 40 per cent hematocrit) 500 cubic centimeters of citrated blood was transfused on October 4, 1930. This changed the whole picture. The septic temperature subsided, the granulocytes took on a healthy appearance. The prognosis of his previous condition was evidenced by the fact, that, in spite of the wound infection and the septic temperature, the leucocyte count was around 5,000.

The patient now made slow but steady recovery. The wound was dressed daily with dichloramine T. He was up all day for the first time on October 11, 1930. On October 30, 1930, a large, venous dilatation in the popliteal fossa was injected with 500 cubic centimeters of 10 per cent gelatin urethane. The vessel became promptly obliterated. On November 4, 1930, two further injections were made in the calf with the same result. He was discharged from the hospital and was dressed in the office twice a week. The wound completely healed on January 3, 1931. At this time there was complete obliteration of the veins of the lower leg. The ankle was not swollen. The knee joint seemed to contain fluid. About 30 cubic centimeters of a serum transudate was aspirated. The vascular dilatations on the thigh had not recurred. The hemangioma of the scrotum and gluteal region were present but did not seem to cause any disturbance. The patient was now free of pain, but the limb was weak and the knee joint would fill up intermittently with fluid.

On April 5, 1931, the gluteal portion of the hemangioma was injected with 50 cubic centimeters of alcohol, and very instructive picture was obtained. A large feeding vessel was visualized, which may represent the connection with the general vascular system (Fig. 5). This feeding vessel was later injected with 10 per cent gelatin urethane solution, which resulted in marked decrease of the mass.

The histological report (Dr. E. Vaughan) of the removed vascular mass was as follows (Fig. 6). Spectrum exhibits 4 areas. It consists of 3 pieces of tissue 7 by 4 by 0.5 centimeters, 5 by 4.5 by 0.5 centimeters, and 1 by 0.75 centimeters. It is made up of fatty connective tissue, translocated, containing vascular structures. Histologically stained sections show fibrous and fatty connective tissue in which are seen a large number of blood channels, varying from tiny and normal appearing capillaries to large sinuses. The latter have a differentiated wall in which muscle cannot be readily identified. They are often divided into compartments by irregular folds. The fibrous for the most part is of normal endothelium, but in places there is evidence of hypertrophy and hyperplasia.

Summary. A 30 year old boy had noticed bluish discolorations on his left leg, thigh, and scrotum since the age of 5 years. At the age of 14 with the onset of puberty a rapid enlargement of the vascular dilatations took place. Particularly the mass in the popliteal fossa grew rapidly. At the age of 15 an operation was done with a partial removal of the growths, which gave the patient temporary relief for 3 years. He then

toward complications of a high spinal block. The operations should all be done under a tourniquet which is removed before the wound is closed. The muscle fascia should always be opened and the subfascial plane inspected as in the advanced cases venous dilatations are frequently encountered under the fascia. In Case 3 a fascial window was excised as in a Kondoleon operation and the edges of the fascia had to be stitched with a hæmostatic mattress suture, so profuse was the bleeding.

The early recognition and an early radical incision of the vascular anomaly offers the best hope for cure. The early recognition, in the absence of thrills, which occur only at large communications will depend on (1) increased surface temperature on the affected side, because of increased blood supply, (2) lengthening of the limb—this is not always present, and chiefly (3) the presence of mixed (arteriovenous) blood in the vascular dilatations, as emphasized by George Brown. This may be recognized by the color of blood or exactly by determinations of oxygen content with the Van Slyke apparatus.

SUMMARY

Vascular growths of the extremities are not true angiomas but are all due to faulty development. The variations encountered and enumerated as angioma simplex, cavernous and racemose angioma, diffuse phlebectasia, and congenital arteriovenous fistula are all due to the various stages of development in which the aberration from the normal occurred. Five cases are presented which represent various stages of developmental arrest. The methods utilized in diagnosis are discussed.

The visualization of the feeding vessel with X-ray may lead the surgeon to a direct attack of the anomalous communication. Early radical excision supplemented in suitable cases with oblit-

erative injections offers the best hope for permanent results.

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branches had to be implanted into the proximal stump. Fine parafilmated black silk sutures were used, only the pericardium being caught. Fine interrupted catgut sutures were used to cover the nerve suture. Skin was closed with interrupted silk-worm gut. A plaster-of-paris splint was applied on exterior surface of limb to maintain flexion.

There was some swelling after the operation but the wound healed by primary intention. The splint was removed on the tenth day and slowly extension was permitted. The red cell count was down to 3,400,000 with 55 per cent hemoglobin. From 15 to 20 cubic centimeters of blood were injected intravascularly every second day four times, which rapidly improved the blood picture. She was discharged on April 28, 1913 with 4,677,000 red cells and a hemoglobin of 67 per cent. X-ray treatment of the solitary cutaneous angioma has been started.

The histological report of the anomalous vessel, which was excised in three successive stages, follows (Dr. S. Vaughan). The specimen is a 13 centimeter segment of blood vessel, the diameter of which is from 6 to 8 millimeters (Fig. 1). The wall varies from 1 to 2 millimeters in thickness. There are no calcium deposits, and the lumen is filled with a blood clot. Under the microscope a large vessel with an irregularly thick wall is seen. This is of a peculiar appearance and has the thickness of an artery but is poorly divided into layers. The media adjacent to the intima contains a large number of longitudinal muscle fibers. No elastic membrane is seen. The lumen is almost completely occluded by a large thrombus which shows organization in places. Diagnosis: large, atypical and thrombotic vessel (Fig. 14).

Summary. A 16 year old girl, who was born with a large vascular nevus on the lateral aspect of the left thigh and leg, first noticed swollen vessels on the lateral aspect of the left thigh at the age of 10 years. There were repeated hemorrhages from small cutaneous vessels. She was given several treatments of radium and X-ray with no results. On three successive operations a large anomalous vessel, which was not recognizable before operation, was removed from the thigh down to the dorsum of the foot. Histologically it proved to be an undifferentiated vessel mostly occluded by a thrombus. A nerve injury which followed the second operation was also repaired. The small cutaneous angiomas, which bled readily were subjected to X-ray treatment. The progress is definitely arrested, the limb is longer and slightly edematous, but has good function.

CASE 5. Mrs. M. L., aged 45 years, was only examined and treated at the Northwestern University Clinic and therefore no intensive study was possible. In the left popliteal fossa spongy vascular areas has been present, as long as she can remember. This was diagnosed as varicose veins, and repeatedly injected by her physician, without success. On examination multiple tortuous vessels were seen, occupying an area of 5 by 4 centimeters, in the left popliteal fossa. There seemed to be no pulsation in this mass, but it could be readily emptied on pressure and seemed to fill up from below. There was no visible enlargement of the major or minor saphenous vein. Blood aspirated from a vessel was bright red, oxygenated blood, but the oxygen content of the blood was not determined. The

whole mass was excised in the dispassary (Fig. 13) and the following histological report obtained: A large number of blood vessels were seen, with hardly more than a thickened endothelial lining. The endothelial cells were large and not quite regular. These minute vessels did not lead themselves to differentiation.

Summary. A 45 year old woman had a localized vascular mass in the left popliteal fossa, ever since she could remember. This was treated with injections unsuccessfully. The excised mass showed a network of multiple endothelial spaces, explaining the failure of injection treatment. It represents the retiform stage with an arrest of development.

The five cases presented here illustrate various types of anomalies occurring in peripheral vessels. Thus Case 4 presented multiple capillary angiomas, which are localized remnants of the primitive capillary net. Case 5 represents a later stage a number of parallel vascular tubes which have not fused sufficiently. Case 3 also belongs to this stage although a much more diffuse involvement of the left lower limb was seen. It was practically inoperable, but an arrest of the disease was possible. Case 1 showed an almost perfect separation of vessels with the exception of the anomalous communication in the palmar arch, whereas Cases 2 and 4 showed a persistent anomalous vessel, primitive in histological structure. The former was operated upon at an early stage with perfect restoration of function.

In studying these histories one cannot help coming to the conclusion that these vascular anomalies are recognizable at an early stage and that they all seemed to be aggravated at puberty. If allowed to progress or if treated with insufficient measures, they become practically inoperable as the vascular masses invade the muscles and may even extend into the bone marrow. Cases 2 and 5 have had early excision, and no sign of recurrence for over 2 years. The other cases have progressed to a stage where a full restoration of function cannot be expected. Nevertheless, a radical excision of the vascular masses, but chiefly the interruption of arteriovenous communications, helped to arrest the anomaly. These operations are extensive and should be performed in several stages. Shock occurred in both Cases 3 and 4, probably from the loss of blood. It seems wise to operate upon these patients in stages and under local anesthesia. The 2 patients, who had involvement of the upper extremities, were operated upon under brachial plexus block, whereas the lower extremities can conveniently be anesthetized with a low spinal anesthesia, which has all the advantages of a spinal anesthesia and none of the un-

or, with less advanced union, would eliminate maintenance of reduction by intra-oral fixation. In double fractures or posterior fractures it becomes most important, therefore, to secure proper reduction and fixation at once. With advanced union in any serious grade of malposition, operative reduction becomes a necessity. Delayed union and non-union are not frequent in the mandible, but, when present, are the result of the same influences and factors which govern lack of bone repair in general.

2 *Proper occlusion of the teeth* As a second principle in management, proper occlusion of the teeth should not be overlooked as a matter that can be passed by lightly for future correction by a competent orthodontist. The time consuming element is already considerable in the treatment of the more complex fractures, and all possible adjustment should be made during early treatment. From the objective standpoint there is no better guide to correct reduction and fixation than the relationship of the teeth. Most mandibular teeth are inclined to the oral side of their maxillary neighbors. The oral cusps of molars and premolars are mesial to the corresponding inner cusps of the upper teeth. Anteriorly the more common mechanism of occlusion finds the "bite" a closed one in which the lower incisors are directed in a plane slightly posterior to the superior incisors. It is but rarely that a perfect end-to-end occlusion is met anteriorly. The cusp erosion present on occlusal surfaces of maxillary and mandibular teeth demonstrates clearly the type of occlusion normal to that individual. In the presence of displacement, fixation that reapproximates this relationship is a sure criterion of accurate reduction of fragments. Extremely loose teeth, of course, are not to be taken as a guide in this sense. These simple orthodontic facts, though primarily a matter of expert concern, nevertheless should be known to the surgeon, as dental consultation and aid in outlying communities may not be available. Recognition of the type and mechanism of occlusion in the absence of the very best X-ray work is often the only certain guide toward efficient reduction and fixation.

3 *Proper function of the mandible as a whole* Under the third requirement of management, the proper function of the mandible as a whole is emphasized as a prime motive for this paper. The mandible is formed by fusion of two symmetrical halves during the first or second year. In function the mandible is peculiar in having a double articular mechanism, connected by a long arc with a joint at each extreme of the bone. This

arc, or fused ramus, is the only means of preserving symmetry or balanced joint motion. Constant parallelism of rotational axes is necessary at the temporomandibular articulations for this one bone to function as a unit with two joints. The mandible is motivated by a double set of identical muscles which are complementary and synergistic only when the bone functions as a whole. Each temporomandibular joint is a true arthrodial diarthrosis with a double compartment formed by an intra-articular meniscus interposed between the glenoid fossa and the condylar head. This arrangement, by capsular laxity, permits a double type of motion—a gliding motion in which the condyle partially luxates forward on the crest of the glenoid fossa, and a true hinge motion around an obliquely transverse axis. Though this generous range and character of motion exists for each joint, function is not possible without motion in both joints. It follows, therefore, that derangement altering the mechanical requirements in one joint must influence in varying degree the same requirements in the other joint. From these dynamic considerations it can be said that the elements of the mandible sharing each temporomandibular joint, notably the condyle and vertical ramus, must maintain a constant and symmetric relationship on the two sides. Clinical demonstration proves that only the slightest alteration of this parallel position is compatible with the preservation of good joint function. A given unit of motion on a radius subtends a greater arc as this measured unit approaches the center, or a lessened central excursion as the same measured unit extends distally on the radius. The site of changed relationship in the mandible exerts a corresponding influence at the temporomandibular articulation. In other words, the more posterior the fracture and the closer to the center of joint action, the greater the influence of malalignment on joint relationship. It follows, therefore, that in posterior fracture with displacement, very accurate reduction of fragments is required to preserve temporomandibular joint function, and less margin of error is permissible than is the case in anterior fracture. Anatomically the short posterior fragment is also more easily displaced through the strong muscle pull of temporal and internal pterygoids.

Two cases are illustrated that demonstrate these considerations in a striking way.

Types of intra-oral fixation Conservative treatment in the presence of teeth is condensed into two or three efficient methods of intra-oral fixation. Some form of interdental splint is the best method of fixation in severe fractures, in

MANAGEMENT OF FRACTURE OF THE MANDIBLE

GEORGE C. HENSEL, M.D. F.A.C.S., SAN FRANCISCO

From Department of Orthopedic Surgery, University of California

FRACTURE of the mandible, though fairly frequent in the field of bone injury is surprisingly uncommon under industrial conditions. During a period of 6 to 7 years, a survey of some 40,000 industrial cases presented only 16 fractures of the jaw bones, of which 6 were maxillary and 10 were limited to the mandible. This infrequency suggests the cause for the lack of standard management. Failure to apply certain fundamental requirements in the treatment of fractures of this bone very often leads to an unfortunate permanent handicap.

It is, therefore, the purpose of this paper to call attention to the principles of management, to a frequent complication of mandibular fracture, and to point out means of immobilization which are not only effective at the time but fulfill future physiological and cosmetic requirements.

SITE OF OCCURRENCE

This fracture is usually the result of direct trauma. Subjective symptoms and objective evidences of injury are well defined and will not be dwelt upon except to emphasize the need of X-ray detail in proper projection. Good X-ray work should never be omitted. As fracture of the mandible is often multiple and there may be two fracture lines in the same half of the mandible or in opposite sides, both a direct anteroposterior and an oblique lateral projection, with each side down, should be taken as a matter of routine. If a fracture of the vertical ramus is suspected, an added projection for detail of this ramus should be secured.

The most frequent site of fracture of the mandible is through the horizontal ramus in an area of relatively weak bone near the mental foramen. The fracture line is most often oblique. The second most frequent site is in the area opposite the third molar tooth and just anterior to the angular tuberosity. The simpler double fractures most often include both of these positions. Fractures through the angle vertical ramus, and neck of the condylar process are not so rare as textbooks indicate. A fracture in some portion of the vertical ramus is a frequent complication of a more obvious anterior fracture with displacement. In case of fracture in the last mentioned position, search for such a second fracture always should be made, even in the

absence of clinical suggestion. It is important because double fracture increases the likelihood of displacement. The mechanism of displacement of fragments is essentially a matter of muscle attachment and lines of unopposed force. Where complete fracture occurs through the body and the fracture line does not oppose displacement, the mylohyoid, digastric, geniohyoid, genioGLOSSUS, and platysma muscles depress the anterior fragment while in general, the temporal, masseter and internal pterygoid muscles elevate the posterior fragment.

TREATMENT

It may be considered as axiomatic that some form of dental or intra-oral fixation is necessary in every complete fracture of the mandible, even those without displacement. Nevertheless it is surprisingly common to find early treatment limited to the application of a Barton bandage or a related type of external appliance. Fractures that exhibit a good result with such care would do equally well with none at all. Opposing muscle pull with a resultant line of force at 90 degrees or more usually will effect displacement—if not in a gross sense, certainly to the degree that improper dental occlusion results.

Treatment in each case whether conservative or radical should achieve these three results: (1) bony union, (2) proper occlusion of the teeth, and (3) proper function of the mandible as a whole. The first is given universal recognition, the second more or less thought and attention, and the third commonly is overlooked.

1. **Bony union.** Bony union as a prime requisite in management of this fracture is fortunately not difficult to secure under average circumstances. Good functional union with little risk of displacement will usually obtain in 3 to 4 weeks in ordinary fractures and in a parallel length of time in the more complex fractures. Union is favored by secure immobilization during early callus formation, by good apposition of fragments, and by aseptic conditions. Conversely absence of these factors inhibits union. Because of the inherent tendency of this bone to heal rapidly it should be stressed that union in malposition, even with overriding of fragments, may be well advanced in 5 weeks. This situation would make manipulative reduction impossible

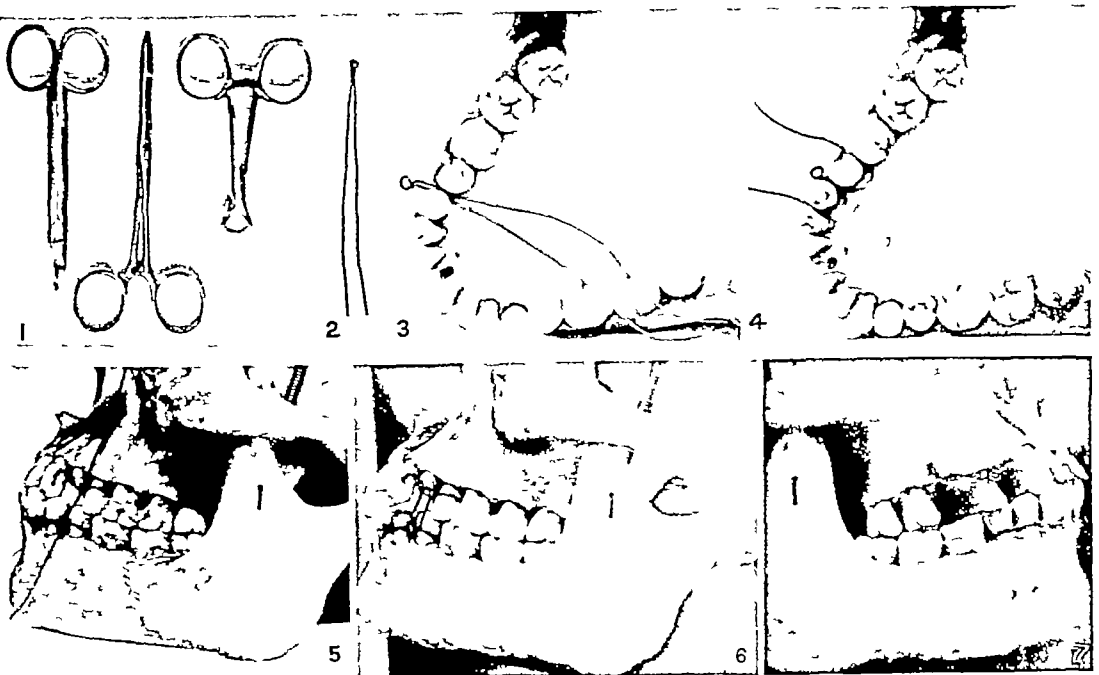


Fig 1 Instruments required for manipulating wire, towel clamp, haemostatic forceps, and short-nosed scissors

Fig 2 Wire twisted to form eyelet.

Fig 3 Ends of eyelet wire inserted between premolar teeth

Fig 4 Ends of eyelet wire carried around premolar teeth back to buccal surface

Fig 5 Eyelet wires attached to upper and lower premolar teeth. Connecting wire passed through eyelets

Fig 6 Upper and lower teeth fixed in occlusion by connecting wire passed through eyelets. Ends of wires twisted, cut off, and bent over

Fig 7 Eyelet wire attached to single tooth in upper jaw

(Figures 1 to 7 from Ivy, Surg, Gynec. & Obst.)

ligation between the two jaws. By the use of bands there is much less tendency toward slipping or breaking of connecting wire ligatures, and larger wire may be used.

Fractures of the mandible, as in all bone fractures between muscle origin and insertion, have little or no tendency toward linear separation. Where this does obtain through comminution or loss of substance, traction or fixation in the long axis of the bone may be effected equally well by separate wire ligatures between the bands, or between the eyelets of the wire method of Oliver and Ivy. Moderately loosened teeth should not be extracted at once, as they may again become fixed.

General considerations. General measures should be directed toward careful and constant mouth hygiene. Many mandibular fractures are compound in the sense of perforating the buccal cavity or extending into the summit of an alveolar process. In either case such a fracture is potentially septic. In addition to an alkaline

mouth wash at hourly intervals the teeth should be cleansed with a soft brush or cotton applicator, and a mild cleansing lotion.

A long standing fetish has prevailed to the effect that immobilization of the mandible should not be completed until all danger of postanæsthetic vomiting has passed. To await such a time prevents local difficulties in securing the most accurate reduction and occlusion. In a series of 18 cases of immediate fixation of the mandible under general anaesthesia, there has been no difficulty from vomiting or pulmonary complication. In fact, in but 2 instances did vomiting occur at all. The depth of anaesthesia for this work need not be great. Solid food should be withheld for 12 hours prior to operation. Any vomiting that occurs will, therefore, consist of liquid gastric content which is passed easily around the posterior molars and through the interspaces of the teeth. Before recovering consciousness or reflexes, the patient should be placed in a ventral prone position without head pillows. A nurse or trained

cases of marked displacement, or with marked comminution of fragments. An orthodontic splint made from a plaster impression satisfies all requirements of treatment, and will often suffice as a permanent fixture until healing is complete. There is, of course, much practical difficulty in its early use. The preparation of such a splint demands experience and a days' time. This, for obvious reasons, may be impossible under conditions in which a given fracture may occur. During this interval the more serious fractures with displacement are in a process of repair in malposition with increasing deformity. Therefore, when at all possible, immediate fixation of fragments should be secured. For the average mandibular fracture, ligation of the teeth through one or another should be carried out, the criteria for accurate reduction being kept in mind.

In bilateral or difficult fractures the application of Hammond's apparatus is quite serviceable and secure. This consists of malleable wire encircled around the last molars with a continuous band on both labial and oral surfaces. This requires considerable skill to mold properly and fit securely before cross-wiring through the interproximal spaces. One or two recently devised patent splints are also quite serviceable. These are adjustable to the contour of the teeth on the labial side and are attached to the teeth by wiring. One splint is attached to each jaw and then the mandible is immobilized by wiring these splints together securely. However such splints are not by any means foolproof and, unless carefully applied, will not guarantee accurate reduction. The choice of a splint will be determined by the type of fracture at hand.

In the majority of mandibular fractures some form of dental ligation is most practical for immediate fixation and is even preferable to any form of splint, both from the ease of application and from the absence of false reliance on complex methods of splint wiring. Interdental splints, unless most accurately applied, often cover cusp surfaces and when removed there may be considerable mal-occlusion. Ligation, when neatly and effectively performed leaves a clear view of dental occlusion allows easy replacement and adjustment, and permits better hygiene of the mouth and teeth.

A method that I have employed quite satisfactorily is that devised by Oliver modified and described by R. H. Ivy (Figs. 1 to 7). With a little practice, any surgeon should be able to use this method effectively. The wire used should be strong, yet malleable, and of such a size that it

will pass freely in the space between the neck of the teeth. Two kinds of wire are recommended, No. 22 to 23 gauge copper wire, and the larger size, No. 24 to 26 gauge Angle's brass ligature wire. These are obtainable in any dental supply house. In emergency soft iron or silver wire may be used. A fine sized orthodontic ligature wire 0.5 millimeter thick with non-corrosive properties is ideal, but not yet obtainable in supply houses. In applying wire ligation of the teeth, the instruments needed are a pair of blunt, short blade scissors (Crown and Collar) a towel clamp and wire forceps.

The method of application is demonstrated in Figures 1 to 7. Before applying the wire to the teeth a 4 or 5 inch length is doubled around closed hemostat blades and the long ends are twisted to form an eyelet about 2 millimeters in diameter. Both long ends are passed through an interspace selected leaving the eyelet on the labial side of the interspace. The ends are then separated and passed from the oral side outward around the neck of each neighboring tooth, the eyelet being held in place with the towel clamp. The ends are then gathered and twisted securely under the eyelet on the upper teeth and above the eyelet on the lowers. Both eyelets then are engaged with a short length of separate wire, and this is twisted sufficiently to effect firm traction between the upper and lower eyelets. All free ends are cut short and bent laterally to avoid mucous membrane irritation. Selected teeth on the opposite side, or incisor area, are then bound in similar fashion. This ligation with eyelet anchorage may be applied to a single tooth. The position of the eyelet may be so fashioned in relation to the upper or lower teeth, that an oblique pull may be secured where needed. Several interspaces between uppers and lowers may likewise be omitted to produce an extremely oblique pull. Through this type of ligation, immediate reduction often may be effected. Tightening and adjustment of the connecting ligatures will most often be needed after 24 hours, and periodically thereafter. Should a connecting wire ligature break it may be replaced easily without disturbing the eyelets.

A more substantial type of fixation is the application of either permanent or removable orthodontic bands to individual teeth. The permanent bands require a day or more to apply but are most satisfactory when such delay is not prohibitive. Removable orthodontic bands for individual teeth are procurable at supply houses, and may be applied easily with little practice. Both the latter and permanent bands have a hook or fastening projection on the labial side for



Fig 13. Case S A Postoperative correction with union
Note re-alignment of right ascending ramus

The fracture line often extends into an alveolar process surrounding the apex of a tooth. Both of these situations invite infection. In either case early infection of soft tissues may occur. Fortunately, true bone infection does not occur often. When osteomyelitis occurs, surgical intervention is necessary either externally or through the mouth, as may be indicated by the site and extent of bone involvement. In fractures entering an alveolar process alone, or extending to the oral mucous membrane, bony union without infection often occurs. If this happens in mal-position, operative correction is accompanied usually by infection.

Broken, loosened, or displaced teeth adjoining the fracture line are common. Severe hemorrhage occasionally is present in marked injury.

Late complications. Osteomyelitis, local or diffuse, is, fortunately, uncommon. Non-union complicates gunshot injuries with loss of substance, and is comparatively rare in other types of mandibular fracture. Mal-occlusion is a very frequent complication in even simpler cases. Devitalized teeth occur when the fracture line includes the apex of the alveolar cavity of such teeth. These should, however, be distinguished from loose teeth which are not necessarily devitalized. Mal-union of the mandible results in changed dynamics of this bone as a whole. When displacement is not accurately reduced the ascending ramus rotates on a vertical axis. This rotation results in derangement in one or both temporomandibular joints, which is expressed clinically in terms of local pain at these joints and limitation of mandibular excursion in opening the mouth.



Fig 14. Case S A Mal-occlusion. Orthodontic bands in place for fixation after operation. Mouth opening limited to $\frac{1}{4}$ of an inch, with marked discomfort both temporomandibular joints.

In opening, the mandible may deviate to the affected side. Late traumatic arthritis of the temporomandibular joint often complicates posterior fracture. Occasionally, fractures involving the condylar process result in ankylosis of the corresponding temporomandibular joint.

SUMMARY

- 1 Double fracture of the mandible is common. Search for a second fracture always should be made.
- 2 Three X-ray projections should be secured routinely.
- 3 Treatment should have as its goal a result that fulfills three requirements: (1) bony union, (2) proper occlusion of the teeth, and (3) proper function of the mandible as a whole.
- 4 Accurate reduction with intra-oral fixation of fragments should be effected promptly.
- 5 Moderately loose teeth should not be extracted; they may become firmly fixed as repair proceeds.
- 6 Dental attention should be given during and after union.
- 7 Severe mal-union, non-union, and bone infection require operative care.
- 8 Rotation of the ascending ramus complicates fractures with displacement. Union in mal-position with such rotation of the ascending ramus gives rise to permanent derangement of temporomandibular joints and impaired function of the mandible as a whole.

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Fig. 8. Case A.P. Fracture with marked displacement left premaxilla area.

attendant should be present constantly while vomiting may last. If urgent difficulty occurs from vomiting the wire ligatures can be cut instantly. Local anesthesia is applicable occasionally but I do not advise its routine use, since most manipulative work is bilateral and often in a potentially infected field.

LATE TREATMENT

Late treatment deals with the failure to secure fundamental requirements. In severe fractures this is often unavoidable. Late or final treatment is directed along two lines. The first is



Fig. 1. Case S.A. Mal-union 7 weeks after injury. Fracture left premaxilla area. Right angle. Note deviation of jaw to left. Mal-occlusion. Thickness right ascending ramus, denoting rotation of this ramus.

surgical correction because of mal-union, non-union, or osteomyelitis. In any of these complications, operative care is required. Surgical correction of complicated late cases forms an interesting technical field, but will not be discussed in this paper. The second consideration in late treatment is dental reconstruction of injured or missing teeth and orthodontic correction of displacements. In any case a competent dentist should examine the teeth toward final adjustment.

COMPLICATIONS

Complications may be early or remote. In the recent case, fracture of the base of the skull or neighboring facial bones should be kept in mind. With a severe fracture, compounding of one or both fragments into the oral cavity may occur.



Fig. 9. left. Case A.P. Flattening and depression left horizontal ramus. Rotation ascending ramus and restriction mandibular movement.

Fig. 9. Case A.P. Limitation mandibular excursion. Marked dislocation of teeth.



Fig. 2. Case S.A. Right mandible with fracture near angle, apparently in good position. Actually much displacement with rotation of posterior fragment (ascending ramus).



Fig. 1. Tumor, actual size. Cross section of tumor. Weight 72 grams. 6½ inches circumference.

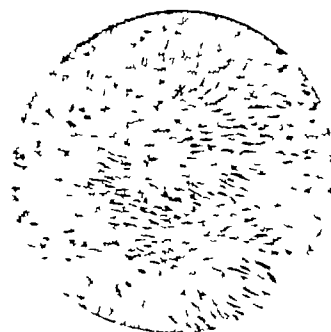


Fig. 2. Photomicrograph of tumor.

J. P. Tourneux, in 1920, reporting the case of a pure fibroma found in a man of 48, says: 'A pure fibroma, a single tumor, is by no means uncommon in the mesentery (referring to adults). Its presence is often recognized by the patient long before any symptoms occur and early diagnosis and operation is imperative as this is the tumor which, as age advances, is apt to assume the serious character of a spindle-cell sarcoma.'

A research of the bibliography on solid mesenteric tumors discloses but one case of pure fibroma of the mesentery in a child, the one listed by Greer and operated upon by Folet. Many of the mesenteric tumors are repetitions of those already reported by Harris and Herzog. Greer and Szenes. Out of these lists, 128 cases have been taken as actual ones on which to base our findings. In all of these 128 cases only 16 pure fibromas were found, 7 in women, 4 in men, 4 no data given, and 1 found in a child 10 years of age. Twelve were operated upon, 8 recovered, and in 4 cases no data were given. Mesenteric tumors were found in children as follows: fibroma (Greer's and personal case), 2, lymphosarcoma 3, round celled sarcoma, 2, teratoma, 1, fibrous tissue, fat, cartilage, calcareous material, 1, malignant lymphoma, 1, lipoma, 1, fibromyxoma, 1, multiple fibromata, 1, angio-sarcoma, 1, no data given, 2, total, 16.

Results: died, 6, recovered, 5, no data given 5 total, 16.

CONCLUSIONS

A careful study of the literature, to which only brief reference has been made, establishes the rarity of the occurrence of solid fibromatous tumors of the mesentery in children. The case here reported, is seemingly the second observed, of course, others may not have been recorded.

The writer desires to emphasize the fact that all tumors of the mesentery whether simple cysts,

multilocular cysts, or solid tumors, should be operated upon early, and should be treated by marsupialization (the cysts), or enucleation-excision whenever this is practicable. The writer's personal experience of 4 patients operated upon, three reported (14), indicates the wisdom of this practice. Seldom is it necessary to excise the intestine forming the periphery of the tumor, although it may seemingly be so. Such practice adds materially to the danger of operation. Reference to the writer's (12) papers will tell of the technique by which resection of the intestine may in some instances at least, be avoided, and when carried out the danger minimized (15). Anastomosis clamps such as those of Dowd Rankin, and Partipilo will add much in reducing the mortality in intestinal resection.

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SOLID PURE FIBROMA OF THE MESENTERY IN CHILDREN

J. E. SUMMERS, M.D., F.A.C.S. OMAHA, NEBRASKA

A REFERENCE to the literature on solid tumors of the mesentery indicates that the finding of pure fibromata has been a rare occurrence, especially among children. The following case is of interest therefore.

A healthy appearing, bright little, three year old girl was sent to me for an opinion June 15, '03 by Dr. John P. Gilligan, Nebraska City. The history was that about one month earlier the mother while bathing the child detected a small tumor of the abdomen. Every day the tumor seemed to be felt in a different location, and, as it had grown considerably since first noticed the mother consulted her physician.

There was nothing unusual in any way in the family history or that of the child. She had always been healthy. The tumor felt to be about the size of a new potato, was hard and very movable, could be pushed into any quarter of the abdomen, most easily under the left costal arch. The absence of tenderness and fixation and the high mobility could only classify the tumor as one of the mesentery, away from either end and somewhere toward its center. I was inclined to regard it as a sarcoma, considering the age of the patient and the rapid growth of the tumor. Early operation was advised. This was carried out at St. Mary's Hospital, Nebraska City. Dr. Gilligan assisting and in charge of the after care.

The tumor was situated in the mesentery of the lower jejunum, free from adhesions, and was with little difficulty peeled out. It had an intact, thin capsule. There was some trouble in controlling the oozing and obliterating the cavity from which the growth had been removed. The convalescence was normal and the child was taken home in a few days. The nature of the growth, a pure solid fibroma, precludes non-recurrence.

Pathological report. Sections of the tumor showed it to consist of irregularly interlacing bands of cells, all of which appeared to be of rather uniform type, considerably elongated spindle, with relatively little cytoplasm, most of the interlacing material being fibrils in character. The distribution of the cells in interweaving bands suggested a myofibromatous character but differential staining failed to reveal the presence of muscular elements. Nowhere was there apparent evidence of unduly increased or lessened growth.

Diagnosis: hard fibroma. (Drs. Eggers and Dunn, Pathological Laboratory of the University of Nebraska College of Medicine.)

In January 1897 Harris and Herzog reporting a solid mesenteric tumor referred to 65 additional cases, of which only 5 were in children from 1 to 10 years of age. Of the children's cases all were mixed types of tumors—no fibromata, of the adults only 5 fibromata.

W. H. Greer in 1911 reported in a summary of 33 mesenteric tumors one pure fibroma in a child, operated upon by Folet. In a girl 10 years of age, a tumor about the size of two fists was casually discovered. The tumor was enucleated

and the wound closed. The growth was attached between the folds of the mesentery. It was a fibroma and weighed 4 pounds. Patient recovered. Two other children in this list had mixed types of tumors.

Dr. Alfred Szentes, in 1918, in his report of 60 cases of solid mesenteric tumors, also mentions the case of the small girl referred to by Greer. Three other children were cited as cases in which sarcomatous tumors were found. Eighteen of the 60 cases were fibromata. None other than Greer's was a pure fibroma among the children. Many of his cases are to be found among the lists of Harris and Herzog, and Greer.

E. S. Judd, and J. R. McVey of the Mayo Clinic, in 1919 reported a case of fibromyoma of the mesentery in a woman 25 years of age. They do not list any other cases from the clinic and make no reference to children. Their paper gives a short résumé of the works of Harris and Herzog, Bowers, Greer and Bigelow and Forman, only one of whom, Greer refers to the case of a pure fibroma in a child. In concluding they say, "undoubtedly earlier diagnosis and operation will aid materially in lowering the mortality."

Fibromata of the Mesentery with the Report of a Case, was the title of the paper written by J. L. Decourcy and J. J. Maloney of Cincinnati, in 1925. They refer to Greer, Morgagni, Sydenham, Bevan, Kyle, and Sir Bland-Sutton. In their summary of fibromatous mesenteric tumors—40 cases occurring in the last 100 years—these three points were brought out: (1) uncommon occurrence (2) diagnosis difficult, (3) surgical treatment consists of enucleation with or without resection as seems indicated by conditions found.

In his book *The Abdominal Surgery of Children* published in 1928, L. E. Barrington-Ward, writing about solid tumors of the mesentery in children states that fibroma, sarcoma, and lymphosarcoma occur very rarely. He mentions the cases collected by Greer also the one of a boy 3 years of age—nature of tumor not stated—by Cannon and O'Kelly and a girl of 8, teratoma of the mesentery by Jennings Marshall.

"Mesenteric tumors are comparatively rare" writes W. H. Fleisher in an article reporting a case of fibromyoma. He mentions 100 cases collected by Bigelow and Forman, one of which was a lymphosarcoma found in a boy of 6. Harris and Herzog, and Szentes were also referred to.

Investigations have revealed the fact that over 90 per cent of the deaths are in the obstructive group of case. It is the duty of surgical teachers, therefore, to make abundantly clear to students and doctors, and through them to the public, that sudden recurring abdominal colic, associated with vomiting but unattended with any rise in pulse rate or temperature, may indicate the most severe form of acute disease of the appendix. It is more urgent than any form of intestinal obstruction excepting internal strangulation, because it is of the closed loop variety and tension gangrene of the wall develops early, particularly if faecal matter be present in some quantity at the moment of obstruction. The administration of a purgative will accelerate the tension gangrene and precipitate perforation. The public must be informed that abdominal colic demands medical advice, not purgation.

The removal of an acutely obstructed appendix, even gangrenous but unruptured, is unattended by appreciable risk. The rupture of such an appendix, with the resultant spilling of its faeculent content into the free peritoneal cavity, leads to a grave peritonitis, frequently fatal in spite of operation. The diagnosis and removal of an acutely obstructed appendix, unperforated, is a triumph of medicine. Operation after perforation has occurred is but an inadequate effort to repair the evil results which have been caused by delay or mismanagement.

An intelligent appreciation of the pathology and related clinical pictures of the two fundamentally different types of acute disease of the appendix, first by teachers, and through them by students, doctors and, finally, the lay public, will do much to bring the dangerous obstructive cases early and thus to lower the death rate from acute peritonitis and its sequelæ.

D P D WILKIE

RENAL PTOSIS

IT would hardly seem necessary to reopen a subject for discussion which has been settled and buried several times in the last 30 years. Yet, when it is resurrected with somewhat altered features, and set going again with new supporters and followers, it must be dealt with and either reinterred or allowed to go on its way. Surgery for movable kidney has had such a course in recent years and is now enjoying a decided renaissance. Many of the arguments in its favor are not new and consist of the simple story of nephroptosis detectable by palpation, abdominal pain, nephropexy, and cure, at least when so reported from 3 to 6 months later.

The experience of 20 odd years ago, when the operation was widely employed, is surely not forgotten. Many surgeons were enthusiastic about the merits of nephropexy, and cures were claimed as a result of it in a great variety of complaints and conditions, varying from backache to insanity. When symptoms, either similar or referred to other regions, even to the other kidney, reappeared in many cases within a year or more afterward, the operation soon lost its appeal, was largely discontinued, and fell into disrepute. In recent years, renal fixation has been revived by the urologists and we now find that it is spreading rapidly. The question naturally arises: What reasons are there for revival of this procedure? Has any new or overlooked reason for it been found, any new method of diagnosis, any recent discovery in pathology or physiology to substantiate it, and lastly, has a new method of operation been discovered, which not alone fixes the kidney permanently, but the symptoms as well?

The present attitude toward surgical treatment of nephroptosis varies widely. There are the two extreme views, one that surgical

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

FRANKLIN H. MARTIN, M.D.
ALLEN B. KAMAVEL, M.D.
LOYAL DAVIS, M.D.

Managing Editor
Associate Editor
Assistant Editor

DONALD C. BALFOUR, M.D. Associate Editorial Staff

AUGUST 1932

THE FATAL ACUTE APPENDIX

AMID the remarkable advances in abdominal surgery with its steadily decreasing mortality in major procedures, it is disquieting to be faced year by year with a rising death rate in acute diseases of the appendix. We know that a timely operation means practically no mortality. The facilities for dealing with acute abdominal emergencies—hospitals, transport etc.—have improved year by year and the number of trained surgeons has increased *pari passu*. The public, therefore has a right to expect a falling death rate in a malady which lends itself conspicuously to cure by surgery.

There must be some valid reason for the maintenance of a high mortality rate in spite of the great increase in surgical activity in dealing with this type of emergency. Early operation in acute appendicitis is now a dictum with almost every trained practitioner of medicine.

The reason for the ineffectiveness of all our efforts lies in the failure by the profession at large to appreciate the true pathology of the dangerous type of case. Thus while the physi-

cian submits many genuine but mild cases of acute appendicitis to early operation be, from a faulty knowledge of pathology tends to delay over the case in which operation is not only an advisable but in fact a life saving measure.

Over twenty years ago Van Zwaluwenburg, of Riverside California pointed out of what vital importance was obstruction of the lumen of the appendix in producing a fulminating attack of appendicitis. His work, which was published in local journals, has never received the attention or credit which it so justly deserves.

We now know that acute disease of the appendix may broadly speaking, be one of two types. It may be either an infective inflammation of the wall of the organ of itself a relatively harmless disease, or it may be a sudden obstruction of the lumen of the organ which, under certain conditions, may prove a rapidly fatal disease.

The first—true appendicitis—is associated with a clinical picture such as one would expect from an inflammatory lesion present within the abdomen viz rise in pulse rate and temperature, vomiting, aching pain, and local tenderness. Few could fail to diagnose this type. The second, acute appendicular obstruction, gives the clinical picture of an acute intestinal obstruction viz sudden onset spasms of pain, vomiting, but no initial rise of pulse rate or temperature.

It is the pathology of the first few hours of acute appendicular disease which we must study. It is at this stage that the two types—inflammatory and obstructive—stand out clear cut and well defined.

treatment is never indicated, and the other that in most cases of nephroptosis surgical treatment should be applied. There is a third group the members of which believe that nephropexy is indicated in selected cases only. Its members differ widely however as to methods of selection and as to the proportion of patients who should be operated on. The more liberal members of the third group would include many cases with symptoms referred to the kidney whether or not they found any evidence of pyelectasis or urinary retention on urography. They manage to find a considerable proportion of the patients with nephroptosis who are amenable to nephropexy. The conservative element in this group however will insist on definite urographic evidence of renal obstruction, as well as pain referred to the renal region, before advising surgical treatment.

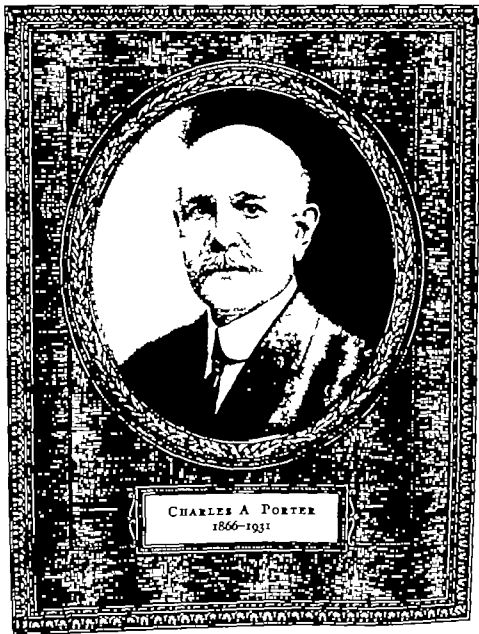
The degree of ptosis visualized in the urogram should not be regarded as an indication for operation. Pyelectasis and renal stasis are the only factors which should influence judgment. The importance of correct interpretation of the urogram is evident in the selection of patients for nephropexy. In extreme cases pyelectasis is easily recognizable. The recognition of a slight degree of pyelectasis however may be difficult, and the personal equation may be a large factor. To complicate matters, a slight degree of pyelectasis may be present which is not the result of obstruction but which is due to an atonic condition of the wall of the pelvis or of the ureter. Such a condition may be the result of a previous renal infection and may not be influenced by renal fixation. In cases about which there is any doubt the existence of stasis may best be determined by means of pyeloscopy.

Symptoms also are significant. Unfortunately in most cases of renal ptosis the

symptoms are not at all typical of renal pain and are frequently masked by complaints which are clearly of a functional type. The pain is often referred to various areas in the abdomen and seldom resembles the clear cut colic usually observed with renal obstruction. In many cases the symptoms can be explained by an inferior nervous system and there is often definite clinical evidence of hysteria, psychoneurosis or constitutional inferiority. In seeking relief from symptoms, these patients will grasp at any suggestion of organic lesion, and will readily permit surgical treatment when so advised. Most of the patients examined will have had several abdominal operations performed without relief.

It must be admitted that nephropexy in cases in which there is no evidence of renal stasis may be followed in some instances by relief of symptoms for a variable period. No reliance, however, can be placed on subjective relief following operation unless a year or more has elapsed. At the end of this time, the symptoms in most cases either will have returned, or other symptoms of a similar nature will have taken their place. It is of greatest importance that urographic studies be made following nephropexy in order to determine the results accomplished. If renal stasis was caused by nephroptosis, evidence of pyelectasis should either be reduced or entirely eliminated. Clinical examination of a considerable number of patients observed several years after having been operated on by various surgeons for nephroptosis would lead one to conclude that the number of patients with renal ptosis that are amenable to relief by renal fixation will be comparatively small. Renal fixation without regard to any evidence of renal obstruction as is frequently being carried out, is to be deplored.

WILLIAM F. BRAABCH, M.D.



MASTER SURGEONS OF AMERICA

CHARLES ALLEN PORTER

ON July 3, 1931, Dr. Porter, a leader in the surgical profession of our country, passed away. In his death we lost one of our most valuable members. He was born in Cambridge, Massachusetts, September 9, 1866, the son of Dr. Charles Burnham and Harriet A. (Allen) Porter. His ancestry was notable, particularly in relation to medicine. His earliest American forebear of whom there is record was Dr. Daniel Porter who came to this country early in the seventeenth century and settled in Farmington, Connecticut. His three sons continued the practice of medicine, two of them in Farmington and one in Waterbury. In the next generation there were also a number of physicians, one of whom, Dr. James Porter, 1745-1780, was a surgeon in the British Army during the Revolution. The medical tradition of the family did not die out and several other members of the family continued the practice of medicine in Rutland, Vermont. Dr. Porter's father, Dr. Charles Burnham Porter, was the son of Dr. James B. Porter and was born in Rutland in 1840, graduating from Harvard College in 1862, and later from the Harvard Medical School and Massachusetts General Hospital. He died in 1909, having been one of the most active and capable surgeons of his time, a demonstrator of anatomy under Oliver Wendell Holmes and an inspiring teacher in the medical school for nearly forty years. His son, the subject of this notice, followed closely and worthily in his father's footsteps. He was graduated from Harvard in 1888, took the then optional course of four years at the Harvard Medical School and, like his father, became a surgical house pupil at the Massachusetts General Hospital.

During his medical school days he never wavered in his interest for that branch of the profession which he later developed in such marked degree. At that time it was possible for students to spend most of the optional fourth year at the hospital, and thus Dr. Porter did. He was already versed in the fundamentals of surgical practice before he had taken his degree and before he had had the more intensive training as a house-pupil. After leaving the hospital he forthwith became an assistant in anatomy, a subject in which naturally he had the keenest interest and a high degree of proficiency. In 1894, he was appointed surgeon to out patients at the Massachusetts General Hospital, and rose steadily through the various grades until he attained the position of surgeon in chief,

which he held for two years preceding his enforced retirement on account of the age limit at sixty. In 1896 he went to Europe, combining travel and study and on his return was appointed an instructor in surgery at the Medical School. From this he advanced successively to assistant professor of surgery 1909-1913 associate professor of surgery 1913-1916 clinical professor of surgery 1916-1918 professor of clinical surgery 1918-1922 when he was appointed John Homans professor of surgery and became emeritus professor on his retirement from active teaching.

In 1915 he enlisted in the first Harvard Unit and served in English field hospitals, a reference to which appeared in the *London Times* of July 8.

His society membership was comprehensive. He was a fellow of the American College of Surgeons, the Society of Clinical Surgery, American Surgical Association, a member of the American Medical Association, Massachusetts Medical Society and the American Association for Cancer Research. His rank as lieutenant colonel in the Medical Corps of the Army made him eligible for the Military Order of the World War. He was also a member of the National Institution of Social Sciences and of many smaller societies in Boston and New England. He was at one time president of the New England Surgical Society and the Boston Surgical Society.

In college he was one of the best athletes in his class. He rowed in his class crew in his freshman year. He played several years on the football team and was one of the best half-backs Harvard ever had. His friendly personality and his athletic prowess made him a great favorite with his classmates. He stood close to the head of his class in the medical school, and was the only student I ever knew who passed the examination in first year anatomy under Dr. Thomas Dwight with a mark of 100 per cent.

Dr. Edward Wyllys Taylor writes as follows regarding his work as teacher:

"Dr. Porter was an admirable teacher, enthusiastic and convincing. He was much given to the use of homely illustrations to bring out technical points which served as more elaborate descriptions would not have done, to drive home the idea he wished to convey. He was rather dogmatic in statement which, dangerous as it may be under certain circumstances, made ample justification in didactic teaching. He was extremely well read in surgery and took particular delight in studying and if possible operating on difficult and obscure cases. Nothing was too hazardous for him to undertake if he felt that surgical interference was justified. He was a skillful director even in his medical school days, which, carried over into the practical aspects of his later work, was naturally an asset of the greatest value. His courage in undertaking an operation from which many would shrink appealed to the students and to his colleagues in the same way that his physical courage on the football field in his college days had appealed to his teammates and opponents alike. Were one to attempt to state his outstanding characteristics, one would perhaps put moral and physical courage first, enthusiasm second and a boundless friendliness third, all happily combined in an unusually charac-

ing personality. He was furthermore peculiarly approachable and quickly made friends with those with whom he came in contact whether as students or colleagues. As one of his younger associates expresses it, 'He was always available for advice or consultation on any surgical matter.'"

He was distinctly a man of action and like many such men found writing irksome and difficult. His literary output, therefore, was not so large as that of others with far fewer ideas to express. What he did publish bore the impress of careful work based on extensive experience. He was a pioneer on the subject of major sepsis and his painstaking work in skin grafting after X-ray burns will long be remembered by those upon whom he operated and by their friends. It will be recalled that literally for years he operated again and again upon the late Dr. Walter Dodd until finally the difficulty got beyond even his power to help. He was widely sought for the treatment of such burns, often a most discouraging task which, true to his temperament, he undertook with enthusiasm and carried out with infinite patience. He was also much interested in surgery of the peripheral nerves, especially in conjunction with the late Dr. Walter E. Paul, and he was one of the first at the Massachusetts General Hospital to operate on the thyroid gland.

A clear indication of the esteem in which he was held not only by his professional friends but by the community in general was shown by the large attendance at his funeral conducted by the Rev. Samuel Eliot at the Arlington Street Church. In his death a distinguished medical line, which has been uninterrupted since the latter part of the seventeenth century, comes to an end, as was likewise the case in the Warren family through the death of Dr. John Warren, in 1928.

He married Dr. Margaret Cochran Dewar of Glasgow, Scotland, in 1898, who, with a son, Charles Burnham Porter, and two daughters, Miss Isabel DeCourcy, and Miss Margaret Dewar, Porter, survive him.

This brief notice cannot be closed better than in the concluding words of a notice published in the *American Journal of Roentgenology* by his friend and patient, Dr. Percy Brown:

"'Allie' Porter, in his surgical warfare against the progressive ravages of profound X-ray burn, usually had a tough opponent in front of a sector onto which he had been brought up only after the resistant forces had become deeply entrenched, whereby he could not always attain his objective. Each new demand upon his skill, however, brought forth reinforcements of enthusiastic energy from sources apparently inexhaustible. Of his brilliant successes, impossible for one of less experience in this field of distinctive pathological phenomena, he spoke little in casual discussion. It remains for the fortunate beneficiaries of his proficiency to recount them, and to carry, in gratitude, the memory of his ministrations and his friendship down the gentle gradient from Life's plateau."

FRED B. LUND

EARLY AMERICAN MEDICAL SCHOOLS

THE ROCK ISLAND MEDICAL COLLEGE AND THE COLLEGE OF PHYSICIANS AND SURGEONS OF THE UPPER MISSISSIPPI

A. E. McEVERS, M.D. F.A.C.S., ROCK ISLAND, ILLINOIS

THE autumn of 1848 marked the opening of the first session of the Rock Island Medical School. Dr. Moses L. Knapp was president and professor of materia medica and therapeutics. The following year the college migrated to Davenport, Iowa, where it was known as the College of Physicians and Surgeons of the Upper Mississippi. In 1848 the Madison Medical College was incorporated by the Wisconsin legislature. In its charter power was granted to create a branch. This was exercised in the organization of the Rock Island Medical School in Rock Island, Illinois. The Madison Medical College never functioned and the Rock Island branch apparently was its only activity due probably to the fact that it was easier to secure a charter from the newly organized legislature in Wisconsin than in Illinois.

A course of lectures was given at Rock Island beginning November 7, 1848, and on February 20, 1849 21 students graduated. This was the only course given at Rock Island. A new corporation was secured in Iowa under the name of College of Physicians and Surgeons of the Upper Mississippi, located at Davenport, Iowa. In letters from John F. Dillon to George A. Bunker in June, 1849 as published in *Zeuch's History of Medical Practice in Illinois* it is indicated that there were some difficulties in maintaining the school in Rock Island and the letter suggested that the anatomical question was a factor.

It was stated that the removal of the school from Rock Island to Davenport was due to the enterprise of Mr. John Forrest, of Davenport, who had erected a commodious building which was leased to the faculty for a term of years. The building is described as containing an amphitheater, lecture rooms, and dissecting rooms lighted from above. At the second session of the school, the faculty was reorganized. Pierce and Goody dropped out, but Richards, Knapp and Armor retained their subjects. Chapman

assumed the chair of anatomy. Sanford had surgery added to his former subjects and Everts taught chemistry and pharmacy. J. D. Fisher was demonstrator of anatomy and A. S. Hudson was prosector to the chair of surgery and obstetrics.

The zeal of some designing men in finding bodies for dissection created some sort of dissatisfaction that affected the College. The shortage of cadavers literally created a new occupation. The teacher's desire for specimens outweighed their better judgment and anyone presenting the cadaver at the door found a willing purchaser for it without questioning. In connection with this the following story is related:

"The next day after a body had been left at the college, a man announced to the doctors that the family of the deceased was very sorry over the disappearance of the body and this gentleman volunteered to relieve the doctors of the evidence, the finding of which most probably would bring about unpleasant complications. (Since the necessity of rioting began for similar cases elsewhere was still fresh in the minds of the doctors, the body was surrendered.) The man then secreted the body on an island and told the faculty that he could recover the body for price. When the price was paid, the body was restored to the bereaved relatives who were relieved that the loved one had not been dissected.

One thing is quite certain that the failure of the school was not due to poor teachers. It is apparent from letters written by Dillon that the professors were an able body of men.

The incorporators were George W. Richards, Moses L. Knapp, Chandler B. Chapman, John Y. Smith, Richard S. Maloney and Nathaniel W. Dean. The first three were on the faculty of the Rock Island School, the others being laymen. Knapp had held a position on the original Rush faculty and both he and Richards had recently severed their connection with the school at La Porte. The faculty of the Rock Island Medical School was given in an advertisement in the Wisconsin *Register* (Madison) September 26, 1848, as

follows "George W Richards, St Charles, Illinois, president, professor of theory and practice of medicine, M L Knapp, Chicago, Illinois, dean, materia medica and therapeutics, C B Chapman, Madison, Wis, surgery, W S Pierce, Rock Island, Illinois, anatomy, John F Sanford, Farmington, Iowa, midwifery and diseases of women and children, Calvin Goudy, Taylorville, Illinois, chemistry and pharmacy, S G Armor, Rockford, Illinois, physiology, pathology, and medical jurisprudence, Orpheus Everts, Fond du Lac, Wisconsin, demonstrator of anatomy"

The life of the school at Davenport was short. In the spring of 1850, the college became the medical department of the State University of Iowa and was moved to Keokuk with the title of the College of Physicians and Surgeons.

The second class of the school that started in Rock Island was graduated at Keokuk in 1850. A class graduated each subsequent year, including 1899. In 1854, it became the Medical Department of the University of Iowa. In 1870, it resumed the name of College of Physicians and Surgeons. In 1899, when it graduated its last class, it merged with Keokuk Medical College to form Keokuk Medical College, College of Physicians and Surgeons. The Iowa Medical College, Keokuk, organized in 1858, was extinct in 1860. The State University of Iowa, College of Medicine, Iowa City, was organized in 1869. The first session began in 1870 and the first class was graduated in 1871, a class graduated each subsequent year. In 1912, it was absorbed by Drake University College of Medicine.

Drake University College of Medicine, Des

Moines, was organized in 1881 as Iowa Eclectic Medical College, the Medical Department of Drake University. In 1883, it assumed the name of Iowa Medical College, Eclectic. In 1882, the Iowa College of Physicians and Surgeons was organized, first class graduated 1883. In 1887, this college became the Medical Department of Drake University, following the suspension of the Iowa Medical College, Eclectic. In 1903, the name changed to Drake University College of Medicine. It absorbed the Keokuk Medical College, College of Physicians and Surgeons in 1908. In 1913 it merged with the State University of Iowa College of Medicine which exists today.

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THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

IN these days of strenuous living filled with the daily problems of medicine, each calling for an immediate solution, it is a pleasure to stop for a few moments and recall with Compton¹ the life of Pasteur.

He is pictured with a vivid pen. The victories in science of this great benefactor of medicine and humanity and his researches, which not only have helped to solve some of the basic problems of bacteriology but also have been of great economic value to the world, have been told in an entrancing manner. Both the layman and the physician will be interested in this book.

A. B. K.

THE same author Ernest Clarke, who translated and edited Haab's *Atlas* thirty-five years ago, has sponsored a much needed volume on the fundus of the eye.² The plates are from the collection of Theodore Hamblin, well selected, and admirably reproduced without exaggeration of the ophthalmoscopic picture. All of the usual pathological fundi are illustrated in the fifty-one plates. The book deserves a place in the library of every ophthalmologist, and it will be useful to all others interested in ophthalmoscopy.

SAMUEL A. DUNE.

THE small but complete textbook on gynecology³ by Foradeika is really an outline for students. It is clearly and simply written and profusely illustrated. The American reader will be surprised to see the Rubin patency apparatus described as "Provia" modification of Currier's model. The recommendation of the author that "the pressure may be carried to 300 millimeters mercury" seems dangerous, for it is well known that pressures above 200 millimeters mercury can produce tubal rupture. The chapter on the treatment of acute gonorrhea includes extensive and prolonged active local treatment which is at variance with modern treatment as is the attempt to establish a clinical picture of acute endometritis. The condition known as fibrosis uteri is here described as chronic metritis. With these exceptions the volume is an excellent, usable textbook for students and should serve as an excellent introduction to the subject of gynecology.

RALPH A. RICE

IN this book⁴ Livingston has compiled a "comprehensive postgraduate review" of the abdomen. He has collected material related to his subject from embryology anatomy, physiology chemistry bacteriology neurology physical diagnosis, and surgery. The presentation of the surgical aspects is not altogether satisfying and perhaps one is captious to wonder at the inclusion of such subjects as lipoma of the thigh, femoral hernia, Raynaud's disease, technique of gastrectomy and of lumbar sympathectomy. A larger number of original illustrations would have added greatly to the book.

The section on visceral neurology is the best. The schematic studies of the viscerogenic reflexes from the gall bladder ureter and appendix are graphic and interesting. The discussions of the skin signs in abdominal pathology and the intraperitoneal fluids are valuable. The eponyms constitute an attractive chapter on medical history.

FREDERICK CHRISTOPHER.

THE previous editions of Dr. Wright's valuable book on *Applied Physiology*⁵ have been reviewed by this journal. It is exceedingly useful to the student of medicine and surgery in that it contains considerable clinical physiology and provides a background for the comprehension and appreciation of many symptoms. It is a popular book, and justly so. Four editions have been published since 1926. This edition has been revised so that it contains many of the current advances in the field covered by the third edition.

A. C. IVE.

THE textbook⁶ on operative gynecology by Halban is ample proof of the fact that the technique of the Halban clinic is unsurpassed and in fact rarely equalled in the Continental clinics. A master of gynecologic operative technique himself, he presents in this volume all the standard operative procedures. He includes his own indications for each operation and makes the work even more personal by giving his own operations for high bladder fixation, gonial prolapse, levator ani suture, ventrosuspension, lateral vaginal drainage, etc. In fact, each operation as set forth is the one of choice in his clinic. The text is, therefore, an accurate reflection of the operative

THE OUPON DE LOON PATENT. By Paul Compton. New York: The Macmillan Company, 1937.

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GYNECOLOGICAL OPERATIONS. By Robert Forde, Dr. Josef Halban. Berlin and Vienna: Urban and Schwarzenberg, 1937.

procedures as carried out in the gynecological clinic of the Krankenhaus Wieden.

The text is written in the clear, forceful style that characterizes all of Halban's writings. The illustrations are profuse, clear, and leave nothing to be desired. This volume should rank, with Doederlein-Kroenig, as among the leading standard German works on this subject. The textbook should be owned and read by every practicing gynecologist.

RALPH A. REIS

IN this¹ and in subsequent volumes, Meyer has attempted to record in concise and condensed form the subject matter presented in basic courses of instruction in roentgenology in the institutions with which he is connected. This brief volume discusses the abnormalities and diseases of the respiratory tract with only the necessary consideration of underlying and closely related structures. Brevity is compensated for, in part, by a complete alphabetical cross index at the end of the volume. Of the illustrations, 113 are line drawings, 68 are reproductions of roentgenograms, and 2 are photographs with descriptive matter. The author has preferred the use of numerous line drawings, showing white on a black background as simulating illustrations sketched on a blackboard during class instruction. Really for the purpose of the work the text is adequate, though for help on individual difficult cases the reader will no doubt consult current literature or more elaborate texts. The book is authoritative, practical, well arranged, and should be valuable for its purpose.

JAMES T. CASE.

SURGICAL treatment implies a knowledge of indications for operative procedures as well as of the technique itself, and while the latter has been adequately treated in numerous textbooks, the subject of indications has not received much attention, such information as is available being scattered throughout various texts and monographs. Reschke, therefore, felt that there was an urgent need for work dealing specifically with the question of indications.

The present work¹ is intended primarily for the practitioner and student who are naturally more concerned with the question of what to do rather than with how to do. The discussion of debatable subjects, moreover, should make it valuable reading for the younger surgical assistants. The first volume is devoted to the consideration of general topics: examination of cardiovascular system, of heart and of metabolism, local anesthesia, general anesthesia, injuries, healing, acute and chronic infections, chronic diseases of joints, rickets, circulatory diseases, amputations, and tumors. The chapters mentioned are well written and, because of their brevity, will not overwhelm the beginner with detail. A valuable feature is an appended bibliography at the end of the

volume, which, while far from being exhaustive, could at least serve as a starting point for further reading.

GEO. HALPERIN

FIFTH in the series of monographs on pathological problems of clinical interest is Professor Dietrich's treatise on thrombosis.² For more than 20 years studies of the author have added valuable knowledge to the problems of thrombosis. The present volume is not intended as a simple summary of the literature. Although the bibliography is quite complete, the author naturally stresses his own findings, which have gradually developed into a general conception of the pathogenesis of thrombosis.

Thrombosis is not a simple intravascular coagulation of the blood. Therefore studies on coagulation-time, of leucocytes, blood platelets, cannot indicate imminent thromboses. The sedimentation test and the changes in blood colloids may give some insight into important changes of the plasma, but they are still not decisive factors.

The slowing down or standstill of the circulation is a favoring factor and their importance can be demonstrated in the structure of the thrombus itself. But circulatory disturbances alone will not explain thrombosis as blood may remain fluid between two ligatures.

Injuries to the endothelium, preferably combined with a slowing down of circulation, lead to localized thrombosis, but do not explain progressive thrombosis. Besides in spontaneous thromboses gross changes in the intima are often absent.

The decisive factor, according to the author's animal experiments, are the correlations between the blood and endothelium, which can be augmented to an increased reactivity of the intima to protein destruction. Precipitations, cellular reactions of the intima can occur, which, if favored by circulatory disturbances and changes in the plasma, will lead to thrombosis.

Infection may favor thrombosis in several ways. Bacteria may be arrested at points of increased reactivity and produce cellular exudates followed by thrombosis. This must occur in multiple simultaneous thrombi, that are found on valves. Or infection may produce a general sensitization of the endothelium, which will form clots if the circulation slows down. Thus from the aseptic bland thrombosis through the thrombosis with marked inflammatory reaction to suppurative phlebitis there is a gradual difference of endothelial reactivity indicating success or complete breakdown of a defensive reaction.

Thrombosis then is a general disease, while a localized thrombus may be a favorable reaction, the progressive, repeated thrombosis, which organizes in places and reforms elsewhere may produce sudden, massive, poorly adherent clots, which are most dangerous from the standpoint of embolism.

Pulmonary embolism occurred in 53 per cent of thromboses in the author's large postmortem material.

¹ CLINICAL ROENTGEN PATHOLOGY OF THORACIC LESIONS. By William H. Meyer. M. D. Philadelphia. Lea & Febiger, 1932.

² CHIRURGISCHE INDIKATIONEN FÜR ARZTE UND STUDIENTEN. Part I. By Prof. Dr. Karl Reschke. Berlin. F. C. W. Vogel, 1932.

³ PATHOLOGIE UND KLINIK IN EINZELARSTELLUNGEN. Vol. 1. THROMBOSE, IHRE GRUNDLAGEN UND IHRE BEDEUTUNG. By Professor Dr. A. Dietrich. Berlin and Vienna. Julius Springer, 1932.

rial. In 35.3 per cent it was fatal. Death occurs if more than two-thirds of the pulmonary circulation is obstructed. Diseased lungs will naturally stand less injury. Only about half of the cases of pulmonary embolism have typical clinical symptoms. Paradox embolism from veins into peripheral arteries is not uncommon through an open foramen ovale.

These are some of the most important statements which have practical significance. No progressive surgeon can ignore this stimulating monograph and its intriguing hypothesis which is backed up by a considerable amount of experimental evidence.

GEZA DE TAKATZ.

UNDER the title of *Surgical Errors and Safeguards* Dr Thorek has given us, in a most refreshing and original style, his viewpoint on a wide range of surgical conditions. It represents the knowledge and experience gained in twenty-five years of surgery and from constant scientific intercourse with some of the world's greatest contemporary surgeons. The operations are taken up regionally and an effort is made to point out what *not* to do under various circumstances. The book contains a great deal of valuable surgical information.

No book can suit everyone, but the following statements particularly are ones with which surgeons might take issue: "Spinal anesthesia in the hands of a well trained surgeon, is a safe method" (p. 24). In the discussion of gastric resections the younger surgeon may be somewhat disquieted by "Do not be guided by the statistics of anyone! Let your own experience be your guide" (p. 131). And despite the recent work of A. H. Montgomery "Short-circuiting operations in intestinal intussusception should not be done. They are dangerous procedures, often followed by failure and death" (p. 300). Legend of Figure 340 p. 367. Carcinoma of the gall-bladder caused by irritation from biliary calculi. "It cannot be too strongly stressed that the uterine vessels should not be ligated unless the ureter is clearly seen to be free" (discussion of hysterectomy p. 553).

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To leave a record of carefully controlled results should be the aim of every surgeon. To have written that record with such a charming, interesting, and typically characteristic literary style adds still another score for a younger generation to emulate.

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INTRACRANIAL TUMORS. NORTH AMERICAN SERIES BY TWO THOUSAND FIFTY-SEVEN CASES WITH SURGICAL-MORTALITY PERCENTAGES. BY HENRY CUSHING. Springfield, Illinois, and Baltimore, Maryland. Charles C. Thomas, 1924.

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rial. In 35.3 per cent it was fatal. Death occurs if more than two-thirds of the pulmonary circulation is obstructed. Diseased lungs will naturally stand less injury. Only about half of the cases of pulmonary embolism have typical clinical symptoms. Paradox embolism from veins into peripheral arteries is not uncommon through an open foramen ovale.

These are some of the most important statements which have practical significance. No progressive surgeon can ignore this stimulating monograph and its intriguing hypothesis which is backed up by a considerable amount of experimental evidence.

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BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

GROWTH AND DEVELOPMENT OF THE CHILD. Part III. NUTRITION. Report of the Committee on Growth and Development, Kenneth D. Blackden, M.D., Chairman. White House Conference on Child Health and Protection. New York and London: The Century Co., 1932.

FORTSCHRITTE AUF DEM GEBIETE DER KINOWITZSTRALOGIE. Edited by Prof. Dr. Griesky. Sep. vol. XII. DIE GEBIRGE UND KLINISCHE UNTERSUCHUNGEN. By Geh. Med. Rat Prof. Dr. Georg Schmidt in collaboration with Dr. med. H. Josephine. Leipzig: Georg Thieme, 1932.

TEXT BOOK OF MARriage AND MEDICAL GYNACOBGICS. By L. L. Doudard. With two chapters contributed by Hunter S. Angove. 3d ed. New York and London: Oxford University Press, 1932.

COMMITTEE EDUCATION REPORT OF THE SUBCOMMITTEE ON OBSTETRIC TEACHING AND EDUCATION. Fred Lyman Adair, M.D. Chairman. White House Conference on Child Health and Protection. New York and London: The Century Co., 1932.

PAPERS ON SURGERY AND OTHER SUBJECTS. By George Tully Vaughan, M.D., L.L.D. F.A.C.S. Washington, D.C. W. F. Roberts Company, 1932.

HUMAN STERILIZATION: THE HISTORY OF THE SEXUAL STERILIZATION MOVEMENT. By J. H. Landman, Ph.D. J.D. J.S.D. New York: The Macmillan Company, 1932.

TRATADO DE PATOLOGIA QUOTIDIANA GENERAL. By Dr. Manuel Bastos Amart. Madrid, Barcelona, Buenos Aires: Editorial Labor S.A., 1932.

CALIFORNIA'S MEDICAL STORY. By Henry Harris, M.D. With an Introduction by Charles Singer, M.D. D.Litt. San Francisco: J. W. Stacey Inc., 1932.

DISEASES OF THE CORONARY ARTERIES (MYOCARDIUM). By Don C. Setton, M.S., M.D. and Harold Leath, Ph.D. M.D. St. Louis. The C. V. Mosby Company, 1932.

VEIN'S HANDBUCH DER GYNACOBGIE. Edited by Dr. W. Staeckel. Vol. VI, 2d ed. 1932. DIE KLINIK DER UTERIN-TUMOREN. Edited by P. Eech, H. Martini, O. Pankow, H. v. Pechan, L. Schönbach. Munich: J. F. Bergmann, 1932.

HUMAN CANCER, ETIOLOGICAL FACTORS, PRECANCEROUS LESIONS, GROWTH, SEVERAL SYMPTOMS DIAGNOSIS PROGNOSIS, PRINCIPLES OF TREATMENT. By Arthur Purdy Stout, M.D. Philadelphia: Lea & Febiger, 1932.

ALLOPATHIC UND SPIRITUELLE ELEKTROKUR. By Dr. med. Hans v. Seemen. With a chapter: Elektrokrämpfe der Geschwulste in Verbindung mit Strahlentherapie. 1932. der Geschwulste in Verbindung mit Strahlentherapie. 1932. der Geschwulste in Verbindung mit Strahlentherapie. 1932.

HOMER'S SURGICAL MONOGRAPHS. PRINCIPLES OF PREOPERATIVE AND POSTOPERATIVE TREATMENT. By Reginald Alex. Cutting, M.D. C.M., M.A., Ph.D. Fore-

word by Rudolph Matas. New York: Paul B. Hoeber Inc., 1932.

AN INTRODUCTION TO AVENTIN RECTAL ANASTOMOSES. By J. Kemper Maddox, M.D. Ch.M.(Syd.), M.R.C.P. (Lond.). With a Foreword by Harold K. Dew, M.B. (Melb.) F.R.C.S. (Eng.) F.R.A.C.S. Australia. Angus & Robertson, Ltd., 1932.

TRANSACTIONS OF THE AMERICAN SURGICAL ASSOCIATION. Vol. XLII. Edited by Walter Estell Lee, M.D. Philadelphia: J. B. Lippincott Company, 1932.

PERIPHERAL INFECTIONS. By James Robert Goodall, O.B.E. B.A., M.D. C.M. D.Sc. Toronto, Canada: Mac-ray Publishing Co., Ltd., 1932.

RECENT WORK OF THOMAS (PHARYNX) OF THE FEMALE PELVIC VISCERA. By E. Hasketh Roberts, F.R.C.S. (Ed.) M.B., B.S. (Lond.). London: Dickinson & Scott, 1932.

PLASTIC SURGERY OF THE NOSE, EAR AND FACE. By Dr. Victor Friedwald. Translated by Geoffrey Morry, M.B., B.S. (Adeleide). D.L.O. (London): Thomas Witherin Manselrich, 1932.

LAO'S GERMAN-ENGLISH DICTIONARY OF TERMS USED IN MEDICINE AND THE ALLIED SCIENCES WITH THEIR PROVERBS. Translated and edited by Milton K. Meyer, M.D. 4th ed. Philadelphia: P. Blakiston's Son & Co., Inc., 1932.

LES DIAGNOSTICS ANATOMO-CLINIQUE DE P. LECHE. RECHERCHES PAR SES ELEVES II. APPAREIL GASTRIQUE DE LA FEMME. Part I. By P. Macleod. Paris: Masson et Cie, 1932.

TECHNIQUE CHIRURGICALE ESTOMAC ET DUODENUM. By Pierre Blandine. Paris: Masson et Cie, 1932.

ESSENTIALS OF SURGERY. By Dott. Oswaldo Amorim. Lar- classo Giuseppe Carabba, 1932.

LE ARCAIDIOLOGIE CHIRURGICAE. By Dott. Ettore Ruggieri. Lar- classo Giuseppe Carabba, 1932.

THE HEART R. T. By Ernest P. Boas, M.D. and Ernest F. Goldschmidt, Ph.D. Springfield, Ill. and Baltimore, Md.: Charles C. Thomas, 1932.

CHROMIUM SURGERY. By Walter Mercer, M.B. Ch.B., F.R.C.S. (Edin.) F.R.S. (Edin.) London: Edward Arnold & Co., 1932.

MAYO CLINIC MONOGRAPHS: MINOR SURGERY OF THE UTERINE TRACT. By Herman C. Bumpus, J. Ph.B., M.D., M.S. F.A.C.S. Philadelphia and London: W. B. Saunders Company, 1932.

ELECTROKUR. By Howard A. Kelly, M.D. L.L.D. F.A.C.S., and Grant E. Ward, M.D., F.A.C.S. Philadelphia and London: W. B. Saunders Company, 1932.

THE MEDICAL ANATOMY. A YEAR BOOK OF TREATMENT AND PRACTICE. Edited by Carry F. Coombs, M.D., F.R.C.P. and A. Randle Short, M.D., B.S. B.Sc. F.R.C.S. Fifth Year. Bristol: John Wright & Sons, Ltd. London: Simpkin Marshall, Ltd., 1932.

LES VOIES DE PERFORATION DES MEMBRANES. By F. M. Cadenat. Tome I, Membrane Supérieure. Paris: G. Doin & Co., 1932.

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

ALLEN B. KANAVEL, Chicago, *President*

J. BENTLEY SQUIER, New York, *President-Elect*

FRANKLIN H. MARTIN, Chicago, *Director-General*

EVARTS A. GRAHAM, St. Louis, *Chairman, Committee on Arrangements*

PLANS FOR THE 22D ANNUAL CLINICAL CONGRESS IN ST. LOUIS

THE surgeons of St. Louis are keenly interested to provide for the Fellows of the American College of Surgeons and their guests at the twenty-second annual Clinical Congress to be held in St. Louis October 17-21, a complete showing of the surgical activities of their city with its two splendid medical schools and many fine large hospitals. The Committee on Arrangements, comprised of representatives of all of the medical institutions of that city, is preparing a program of operative clinics and demonstrations in all branches of surgery—general surgery, gynecology, obstetrics, orthopedics, urology, proctology and surgery of the eye, ear, nose, throat and mouth. Clinics are scheduled for the afternoon of Monday, October 17, beginning at 2 o'clock, and for the mornings and afternoons of each of the four following days.

Clinics and demonstrations will be given at the medical schools of Washington University and St. Louis University, Central Institute for the Deaf, Mallinckrodt Radiological Institute, Oscar Johnson Institute, and at the following hospitals: Alexian Brothers, Barnard Free Skin and Cancer, Barnes, Bethesda, Christian, DePaul, Evangelical Deaconess, Firmin des Loges, Frisco Employes', Jewish, Lutheran, McMillan, Missouri Baptist, Missouri Pacific, Mount St. Rose, St. Anthony's, St. John's, St. Louis Children's, St. Louis City, St. Louis County, St. Louis Maternity, St. Luke's, St. Mary's, St. Mary's Infirmary, Shriner's, United States Marine, Veterans No. 92.

The program, originally published in the June issue of *SURGERY, GYNECOLOGY AND OBSTETRICS* and in the *Bulletin* of the College for June, is to be republished in revised form in the September issue. During the months preceding the Congress the hospital schedules will be further revised and amplified under the direction of the Committee on Arrangements, so that in its final form the program will present a completely detailed schedule of the clinical work to be demonstrated.

COMMITTEE ON ARRANGEMENTS

Evarts A. Graham, *Chairman*
F. A. Jostes, *Secretary*

Executive Committee

Fred Bailey
M. B. Clopton
William T. Coughlin
L. W. Dean
Ellis Fischel
Evarts A. Graham

Roland Hill
F. A. Jostes
W. C. G. Kuchner
H. G. Mudd
Max Myer

Willard Bartlett
Clarence H. Crego, Jr.
W. C. Gibson
William P. Glennon
Max Goldstein
John Green
H. A. Hanser
Harvey J. Howard
Charles E. Hyndman
Walter Jones
R. Emmet Kane
W. E. Leighton
Curtis H. Lohr
William H. Luedde

McKim Marriott
Harvey S. McKay
James Mudd
Louis Rassieur
Francis Reder
William E. Sauer
Otto Schwarz
Alphonse M. Schwitalla
Major Seelig
Omar R. Sevin
Carroll Smith
Max Starkloff
Ross Woolsey
O. B. Zennert

Sub-Committees

Ophthalmology and Otolaryngology—L. W. Dean, Chairman, Max Goldstein, John Green, Harvey J. Howard, William H. Luedde, William E. Sauer
Community Health Meeting—Ellis Fischel, Chairman, Fred Bailey, Charles E. Hyndman, F. A. Jostes, Francis Reder
Publicity—Major Seelig, Chairman.

Modern methods in the treatment of fractures will be demonstrated as a feature of the clinical program, and at several of the hospitals plans are being made for a comprehensive showing of the methods used and the results obtained in the treatment of fractures which forms so large a part of surgical work in large cities and industrial centers. Other important features of the clinical program include demonstrations of the treatment of cancer by surgery, radium and X-ray, the rehabilitation by surgery and physiotherapy of patients injured in industrial and automobile accidents, etc.

The annual meeting of the American College of Surgeons will be held in the ballroom of the Jefferson Hotel on Thursday afternoon beginning at 1:30 for the reception of reports by officers and committees, and the election of officers, regents and governors.

Among the distinguished visitors from abroad who will attend the Clinical Congress is Dr. José Goyanes, Professor of Surgery in the National Academy of Medicine of Madrid Spain and President of the Society of Surgeons of Madrid.

SPECIAL FEATURES

A conference under the auspices of the Board on Traumatic Surgery and Industrial Medicine of the College is being arranged for Friday afternoon in the ballroom of the Jefferson Hotel that will include a discussion of the various phases of this important activity of the College together with a report outlining its present and future activities in respect to a nation-wide survey of the medical and surgical facilities of our industries.

A symposium on fractures on Wednesday afternoon will be presented in co-operation with the Fracture Committee of the College under the Chairmanship of Dr. Charles L. Scudder of Boston. This symposium will deal with methods of diagnosis and treatment of fractures of individual bones—practical presentations by surgeons of wide experience.

A daily exhibition of surgical films in the ballroom of the Statler Hotel is being planned. A large number of new surgical films, both sound and silent will be shown.

EVENING MEETINGS

An outline of the program for a series of evening meetings will be found in the following pages. At the presidential meeting on Monday evening in the ballroom of the Jefferson Hotel, the president elect, Dr. J. Bentley Squier of New York, will be inaugurated and deliver the annual address. On the same evening the John B. Murphy oration in surgery will be delivered by Sir William L. DeCourcy Wheeler of Dublin Ireland.

At scientific sessions on Tuesday, Wednesday and Thursday evenings in the ballroom of the Jefferson Hotel a number of papers on various phases of surgery will be presented by eminent surgeons of the United States, Canada and England.

The annual Convocation of the College will be held on Friday evening in the ballroom of the Jefferson Hotel at which the 1932 class of candidates for Fellowship in the College will be received. The Fellowship address will be delivered

by Robert A. Millikan director of the Norman Bridge Laboratory of Physics of the California Institute of Technology.

Two meetings of special interest to ophthalmologists and otolaryngologists will be held on Tuesday and Thursday evenings in the ballroom of the Statler Hotel with addresses by eminent specialists.

TEACHING OF SURGERY AND THE SURGICAL SPECIALTIES

A committee appointed by the American College of Surgeons is assembling information on the teaching of surgery and the surgical specialties, to be presented at a meeting at two o'clock Wednesday afternoon, October 19, in the Jefferson Hotel. Dr. Fred C. Zapffe of Chicago is secretary of the Committee.

The opinions of chiefs or heads of surgical departments in the undergraduate, graduate, and postgraduate medical schools of the United States and Canada are being solicited. The purpose in view is to present for consideration an outline of approved courses in surgery and the specialties, such outline to be used in building courses in individual schools to meet local demands, needs, and facilities, both as to personnel and equipment.

No attempt will be made to standardize the teaching of surgery or of the specialties. The report will compare the opinions of teachers of these subjects; it will emphasize what they believe to be the best means of imparting fundamental principles and of laying a sound foundation for future development and it will stress the best and most effective undergraduate, graduate and postgraduate training of the surgeon and specialist of the future, based on the consensus of opinion of teachers in these important fields.

HOSPITAL STANDARDIZATION CONFERENCE

For the fifteenth annual Hospital Standardization Conference of the American College of Surgeons beginning on Monday October 17 and continuing through Thursday a highly instructive program of practical value is being prepared consisting of addresses, papers, round table conferences and demonstrations. The entire program is being built around the problems affecting the hospital field at the present time. An opportunity will be given for extemporaneous discussion of problems other than those indicated on the program. Speakers of note from both the United States and Canada will lead the discussions.

There will be two evening sessions—Tuesday evening for hospital trustees, and Wednesday evening for social service workers. These sessions

SYMPOSIUM CANCER IS CURABLE

Thursday, 2 30 P M —Ballroom, Jefferson Hotel

CANCER is curable. It is in the incipient stage of cancer that proper treatment produces the greatest number of cures. Incurable cancers are almost invariably the result of failure of early recognition of the disease. Wise propaganda will disseminate to the public facts about cancer that should be within the knowledge of every man and woman. It will impress upon the public and the practitioners of medicine—the family doctors—the importance of early and periodic advice, based on accurate diagnosis. And nothing will lend greater encouragement to the public than assurance that *cancer is curable*.

Based on these indisputable facts, the College will present a clinical symposium on the afternoon of Thursday, October 20, that will emphasize the curability of cancer.

Each of twenty clinicians will present a summary of five-year cancer cures recorded in his practice. Through the Committee on the Treatment of Malignant Diseases, Dr. Robert B. Greenough, Chairman, the College is in a position to report many five-year cancer cures. But thousands of such cases are unrecorded, and it will be advantageous to the profession, and revolutionize the attitude of the public toward the entire subject, if the College, a thoroughly disinterested body, will record additional cases in the medical literature as proof of the curability of cancer. These brief, definite summaries will be published in the issue of the official journal of the College and the Congress—**SURGERY, GYNECOLOGY AND OBSTETRICS**—which is devoted to the transactions of the Congress.

SYMPOSIUM CANCER CLINICS

Thursday, 9 30 A M —Ballroom, Jefferson Hotel

WHOLESONE dissemination of information on the curability of cancer will impel the educated man and woman to demand facilities for early diagnosis. After careful consideration of all phases of the subject, the American College of Surgeons has taken the stand that the best means immediately available to improve the care of cancer cases, and to reduce the excessive cancer mortality, is through the organization of cancer diagnostician clinics

in already existing hospitals and other approved institutional clinics where cancer can be specially treated.

The symposium on cancer clinics will be participated in by men selected on account of their activities in institutions of different types. Concrete examples of organization for the care of cancer in different types of institutions will be presented, and some of the specific problems that are common to all cancer clinics will be discussed.

will be of interest not only to the respective groups indicated but of general interest to all hospital people.

The conference will conclude with a series of demonstrations of departmental services on Thursday in two St. Louis hospitals, which will show the newest developments in departmental equipment, organization, and management. As a complement to the program there will be an educational exhibit of organization charts, personnel ratio schedules, hospital plans, etc.

A special effort is being made to interest members of governing bodies of hospitals, medical

staffs, and department heads, in addition to hospital executives, in this program. In addition to the program at headquarters there are many things of interest to be seen in the St. Louis hospitals in the way of the newest ideas in construction and equipment.

COMMUNITY HEALTH MEETING

A unique feature of this year's Clinical Congress will be a community health meeting to be held on Wednesday evening, in the gymnasium of the St. Louis University, to which the public will be invited. A number of speakers of renown at-

SURGERY GYNECOLOGY AND OBSTETRICS

ST LOUIS HOTELS AND THEIR RATES

Single	Maximum rates with bath	
	Doubles	Singles
American, Market and Seventh Sts.	\$1.50	\$1.00
American Annex, Market and Sixth Sts.	.50	.50
Chas. Lindell Blvd. at Forest Park	3.00	3.00
Claridge, Locust and Eighteenth Sts.	3.00	3.00
Congress, Union Blvd. and Pershing Ave.	3.00	4.50
Coronado, Lindell Blvd. and Spring Ave.	2.50	3.50
Fabron, Maryland and Euclid Ave.	2.50	4.00
Forest Park, W. Pine Blvd. and Euclid	2.50	4.00
Gatesworth, Union and Lindell Blvds.	3.00	4.00
Jefferson, Twelfth Blvd. and Locust St.	.50	3.00
Kings-Way, Kingshighway and W. Pine	2.50	3.00
Robert E. Lee, Eighteenth and Pine Sts.	.00	3.00
Lemay, Ninth and Washington Ave.	.50	4.00
Maryland, Eleventh and Pine Sts.	1.00	3.00
Mark Twain, Eighth and Pine Sts.	1.00	3.00
Marquette, Eleventh and Washington	1.00	3.00
Marquette, Eleventh and Washington	1.00	3.00
Marquette, Eleventh and Washington	1.00	3.00
Maryland, Ninth and Pine Sts.	2.50	4.00
Mayfair, Eighth and St. Charles Sts.	1.00	3.00
Mayfair, Grand Ave. and Lindell	1.00	3.00
Metropole, Locust and Eleventh Sts.	4.00	5.00
Missouri, Locust and Eleventh Sts.	2.50	4.00
Park Plaza, Kingshighway at Maryland	1.00	4.00
Roosevelt, Delmar and Euclid Ave.	4.00	6.00
Scout, Union Blvd. and Pershing Ave.	4.00	6.00
Statler, Ninth and Washington Sts.	2.50	4.00
Warwick, Fifteenth and Locust Sts.		

tending the Clinical Congress will deliver brief, interesting, instructive talks on health and hospital, illustrated, in most part, by lantern slides and motion pictures. In this way the College offers to the citizens of St. Louis and vicinity an opportunity to participate in its program of health education.

HEADQUARTERS

General headquarters for the Clinical Congress will be established at the Jefferson Hotel, 12th and Locust streets, where the ballroom, Crystal and Ivory rooms and foyers adjacent thereto on the mezzanine and second floors have been reserved for the exclusive use of the Congress for scientific meetings, conferences, registration and ticket bureaus, bulletin boards, executive offices, scientific and technical exhibitions, etc. The ballroom of the Statler Hotel, at Washington and 9th streets, will be utilized daily for film exhibitions and certain scientific sessions.

TECHNICAL EXHIBITION

An interesting feature at headquarters will be the Technical Exhibition for which space has been reserved on the mezzanine floor including the Crystal and Ivory rooms and large foyers adjacent thereto. There will be represented in this exhibition the leading manufacturers of surgical instruments, X-ray apparatus, operating room lights, hospital apparatus of all kinds, ligatures, bandages, pharmaceutical publishers of medical books, etc.

ADVANCE REGISTRATION

Attendance at the St. Louis session will be limited to a number that can be comfortably accommodated at the clinics—the limit of attendance being based upon the result of a survey of the amphitheaters, operating rooms and laboratories in the hospitals and medical schools to determine their capacity for accommodating visitors. It will be necessary, therefore, for those who wish to attend the Clinical Congress in St. Louis to register in advance.

Attendance at all clinics and demonstrations will be controlled by means of special clinic tickets, which plan provides an efficient means for the distribution of the visiting surgeons among the several clinics and insures against overcrowding as the number of tickets issued for any clinic will be limited to the capacity of the room in which that clinic will be given.

A registration fee of \$5.00 is required of each surgeon attending the annual Clinical Congress, such fees providing the funds with which to meet

the expenses of the meeting. To each surgeon registering in advance a formal receipt for the registration fee is issued which receipt is to be exchanged for a general admission card upon his registration at headquarters. This card, which is non-transferable, must be presented in order to secure clinic tickets and admission to the evening meetings.

REDUCED RAILWAY FARES

The railways of the United States and Canada have authorized reduced fares on account of the St. Louis session of the Clinical Congress so that the total fare for the round trip will be one and one-half the ordinary first-class one-way fare. To take advantage of the reduced rates it is necessary to pay the full one-way fare to St. Louis, procuring from the ticket agent when purchasing the ticket a convention certificate, which certificate is to be presented at headquarters for the signature of the general manager of the Clinical Congress and the visé of a special agent of the railways. Upon presentation of a visé certificate to the ticket agent in St. Louis not later than October 25 a ticket for the return journey by the same route as traveled to St. Louis may be purchased at one-half the one-way fare.

In the eastern, central, and southern states and eastern provinces of Canada tickets may be purchased between October 14 and 20 in other sections of the United States and Canada at

(Continued on page 242)

PRELIMINARY PROGRAM FOR EVENING MEETINGS

BALLROOM, JEFFERSON HOTEL

Presidential Meeting—Monday Evening

Invocation

Address of Welcome EVARTS A GRAHAM, M D, St Louis, Chairman, Committee on Arrangements

Introduction of Foreign Guests

Address of Retiring President Intangibles in Surgery ALLEN B KANAVEL, M D, Chicago

Inaugural Address J BENTLEY SQUIER, M D, New York

The John B Murphy Oration in Surgery Pillars of Surgery SIR WILLIAM I DE COURCY WHEELER, M S, F R C S.I, Dublin, Ireland

Tuesday, Wednesday, and Thursday Evenings

Symposium on Surgery of the Large Bowel

Diverticulitis of the Large Bowel VERNON C DAVID, M D, Chicago

The Hopeful Prognosis of Carcinoma of the Colon. FRED W RANKIN, M D, Rochester, Minn

Gynecological Symposium

The Results of Irradiation in the Treatment of Functional Uterine Bleeding Based upon a Study of Four Hundred Cases FLOYD E KEENE, M D, Philadelphia

The Detection of Clinically Latent Cancer of the Cervix WILLIAM P GRAVES, M D, Boston

Fracture Oration Fractures about the Elbow PHILIP D WILSON, M D, Boston

Oration Industrial Medicine and Traumatic Surgery FREDERIC A. BESLEY, M D, Waukegan, Ill

Inflammation SIR GEORGE LENTHAL CHEATLE, K C B, C V O, F R C S, London, England

Bronchiectasis and Its Treatment by Lobectomy in One Stage HAROLD BRUNN, M.D, San Francisco

A Discussion of Some Principles Involved in the Pathology and Treatment of Empyema Thoracis JOSEPH A DANNA, M D, New Orleans

An Experimental and Clinical Study of the Use of Radium in the Brain LOYAL DAVIS, M D, and MAX CUTLER, M.D, Chicago

Some Observations on Appendicitis A Review of Four Thousand Appendectomies J M T FINNEY, JR, M D, Baltimore

Convocation—Friday Evening

Invocation

Conferring of Fellowships

Conferring of Honorary Fellowships

Presidential Address J BENTLEY SQUIER, M D, New York.

Fellowship Address Some New Things in Physics ROBERT ANDREWS MILLIKAN, Ph D, LL.D, Sc.D, Nobel Laureate, Director, Norman Bridge Laboratory of Physics and Chairman of the Executive Committee, California Institute of Technology, Pasadena

SECTION ON OPHTHALMOLOGY AND OTOLARYNGOLOGY

Ballroom, Statler Hotel—Tuesday and Thursday Evenings

Highways and Byways in Ophthalmology HANS BARKAN, M D, San Francisco

History and Development of the Operative Treatment of Facial Palsy ARTHUR B DUEL, M D, New York.

Suppuration of the Petrous Apex in Relationship to Meningitis WELLS P EAGLETON, M.D, Newark, N J

earlier dates. The return journey must be completed within thirty days from date of sale of ticket to St. Louis.

The reduction in fares does not apply to Pullman fares nor to extra fares charged for passage on certain trains. Local railroad ticket agents will supply detailed information with regard to dates of sale, rates, routes, etc. Stop-overs on both the going and return journeys may be had within certain limits.

Full fare must be paid from starting point to St. Louis, and it is essential that a "convention certificate" be obtained from the agent from whom the ticket is purchased. These certificates are to be signed by the general manager of the Clinical Congress and vided by a special railroad agent at Clinical Congress headquarters on or before October 25. No reduction in railroad fares can be secured except in compliance with the regulations outlined and within the dates spec-

fied. It is important to note that the return trip must be made by the same route as that used in going to St. Louis and that the certificate must be deposited at headquarters during the meeting and return ticket purchased not later than October 25.

An exception to the above arrangement is to be noted in the case of persons traveling from points in certain far western states and British Columbia, who will be able to purchase round trip summer excursion tickets which will be on sale up to and including October 15 with a final return limit of October 31. The summer excursion fare is somewhat lower than the convention fare mentioned above, but is available only in certain of the far western states and British Columbia. Tickets sold at summer excursion rates permit traveling to St. Louis by way of a direct route and returning by way of another direct route with liberal stop-over privileges.

SURGERY, GYNECOLOGY AND OBSTETRICS

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THE ETIOLOGY OF GASTRIC AND DUODENAL ULCER¹

EXPERIMENTAL STUDIES

WARREN B. MATTHEWS, M.S., M.D., AND LESTER R. DRAGSTEDT, PH.D., M.D., CHICAGO

From the Department of Surgery of The University of Chicago

DURING the past 15 years there has been a renewed clinical interest in the problems presented by the etiology and pathogenesis of gastric ulcer and a large amount of excellent experimental work has been done which has greatly clarified already existing ideas concerning the significance of various factors in the cause of the disease. Perhaps the most important development during this period has been the successful production of chronic ulcer in the experimental animal. The early literature is replete with unsuccessful attempts to produce a chronic progressive lesion in the gastric or duodenal mucosa of dogs. This effort has served, however, to make evident the great capacity of the gastric mucosa of these animals to heal in the presence of the usual gastric content and after the most extensive mechanical and chemical traumas. Bolton (1913), Friedman and Hamburger (1914), Dragstedt and Vaughn (1924), Shapiro and Ivy (1926), Wolfer (1926), and others have produced chronic gastric ulcers in dogs by methods which are chiefly serviceable in determining the subsequent effect of these ulcers on the secretory and motor function of the stomach but are of less significance in determining the cause of the spontaneous lesion. Ealto (1911) and especially Mann and his associates (1923) must be credited with being the first to develop methods which

regularly lead to the production of chronic ulcers without the use of external destructive agencies. Largely as a result of the experiments of Mann and his associates in this country, the theory that ulcer is due primarily to the corrosive and digestant action of the pepsin-hydrochloric acid of the gastric juice has received a renewed emphasis and for the first time definite experimental support.

In this connection, however, and in spite of the evidence presented in this paper, it must be recognized that in dealing with the clinical problem many diverse agencies may produce an acute lesion in the human stomach. Such a lesion is not ordinarily under optimum environmental conditions for healing and we may list for subsequent examination those more obvious factors which might delay healing and induce chronicity. First, in otherwise healthy individuals it seems likely that the exposure of the acute lesion to the corrosive action of the gastric content would delay healing. In this connection the time of such exposure and the concentration of free acid and of pepsin in the gastric content should be of great significance. Second comes the almost ceaseless motility of the stomach and especially of the pyloric region where chronic ulcers are so prone to develop. Here also the increased motility associated with pylorospasm and retention demands consideration. Third, the possible mechanical effect of coarse

¹This work has been conducted under a grant from the Douglas Smith Foundation for Medical Research of The University of Chicago.

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TABLE I—INTESTINAL ULCER AFTER IMPLANTATION OF STOMACH POUCHES

The incidence of chronic ulcer in the intestine following the implantation of stomach pouches (experimental diverticulum ulcers) Pawlow pouches were used in all cases except Dogs 5 and 6, in which Heidenham pouches were employed

Dog No	Size of pouch	Part of intestine used	Length of experiment	Fate of animal	Description of ulcer	Condition of animal at death
1	Small	Ileum	80 days	Sacrificed	2 x 3 cm	Good. No weight loss
2	Small	Ileum	60 days	Died of distemper	2 x 1.5 cm. Subacute	Poor
3	Small	Ileum	77 days	Sacrificed	4 x 3 cm Chronic	Fair 20% weight loss
4	Small	Ileum	77 days	Sacrificed	2 x 3 cm Chronic	Fair 15% weight loss
5	Small	Ileum	34 days	Peritonitis	4 cm diamete. 2 cm deep Perforated	Good No weight loss
6	Small	Ileum	91 days	Sacrificed	1.5 cm diameter 0.5 cm. deep Chronic	Poor
7	Large	Jejunum	29 days	Peritonitis	Size half hen egg Perforated	Poor
8	Large	Jejunum	51 days	Hæmorrhage	4 cm. wide 4 cm. deep	Good. 10% weight loss
9	Large	Jejunum	92 days	Intussusception	No ulcer	Very poor
10	Large	Jejunum	86 days	Peritonitis	Extensive destruction intestinal wall	Good. No weight loss
11	Large	Jejunum	24 days	Accidentally killed	3 cm. diameter Chronic	Good. No weight loss
12	Large	Jejunum	83 days	Peritonitis	Crater size goose-egg	Very poor
13	Large	Jejunum	98 days	Sacrificed	4 cm wide 4 cm. deep Crater	Poor
14	Large	Jejunum	103 days	Evisceration	No ulcer	Good. No weight loss
15	Large	Jejunum	93 days	Not killed	2 cm diameter Chronic	Good No weight loss
16	Large	Jejunum	22 days	Peritonitis	2 x 4 cm. Perforated	Fair 10% weight loss
17	Large	Jejunum	52 days	Peritonitis	4 x 3 x 3 cm. Chronic	Poor 30% weight loss
18	Large	Jejunum	14 days	Peritonitis	1.5 cm diameter	Good. No weight loss
19	Large	Jejunum	160 days	Peritonitis	Chronic 5 x 4 cm.	Poor 50% weight loss

or gastric ulcer have a gastric content of higher than normal acidity and one which approaches the acidity of pure juice?

THE PRODUCTION OF CHRONIC ULCER BY PURE GASTRIC JUICE

a *Meckel's diverticulum ulcer* Perhaps the most striking evidence to be obtained from human pathology in support of the view that the chemical action of gastric juice may produce a chronic ulcer is the occurrence of such a lesion in the mucosa of the ileum adjacent to the entrance of Meckel's diverticulum Aschner and Karelitz (1930) and Lindau and Wulff (1931) have summarized the clinical literature bearing on this problem and have pointed out that in those cases in which ulcer has been present, islands of heterotopic gastric mucosa, histologically similar to that in the fundus of the stomach, have been almost invariably found in the diverticulum. Additional proof that this heterotopic gastric mucosa is functional has been cited in the

occasional persistence of the vitelline duct as a fistula opening at the umbilicus and discharging an acid proteolytic secretion capable of corroding the skin. Both pepsin and free hydrochloric acid have been detected in this secretion (Lindau and Wulff), and the amount of secretion has been found to increase greatly when food is taken in the stomach. This is undoubtedly due to the stimulating effect of gastric bodies discharged into the general circulation during gastric digestion since secretory nerves to these islands of gastric tissue have not been found. In this connection it should be noted that Ivy and Farrell (1925) autotransplanted small pouches of the fundic portion of the stomach subcutaneously in dogs and observed that following a meal the transplant secreted acid. All nervous connections between the transplant and the main stomach had been severed. The Meckel's diverticulum ulcer invariably occurs adjacent to the heterotopic gastric mucosa but always involves only the mucosa of the ileum

food particles pressed into an acute ulcer by the digestive motility of the stomach is of significance. In addition to these factors operative in healthy persons we must bear in mind a possible generalized decrease in the rate of healing or in the resistance of the gastric or duodenal mucosa to the digestant action of the gastric juice present in individuals rendered cachectic by anemia, food deficiencies, endocrine disturbances etc. through local vascular disease or thrombosis of the gastric blood vessels, decrease in the amount of gastric mucus, etc. Since chronic gastric ulcer is predominantly a disease of young and otherwise healthy adults, it seems improbable that these latter factors play any large rôle in the disease.

The present experiments were designed to determine in so far as possible the rôle of the chemical action of the gastric juice in the cause of ulcer and its relation to the chronicity of these lesions.

Interest in this problem has centered about the pepsin and hydrochloric acid rather than other constituents of the juice because of their great capacity to hydrolyze proteins. The question has been raised "Why does the stomach not digest itself?" It has been commonly assumed that the mucosa lining the gastric wall has some specific resistance to such digestion not possessed by other living tissues and entirely absent in dead protein. An attempt was made by Dragstedt and Vaughn (1924) to secure experimental evidence regarding the resistance of various tissues to gastric digestion. In their experiments, large windows were produced in the stomach of dogs and into these defects were carefully sutured segments of duodenum, jejunum ileum colon, and such organs as spleen and kidney. In no case were these tissues digested away. The exposed surfaces of the spleen and kidney were soon covered by a layer of newly formed gastric mucosa while the mucosa of the duodenal and intestinal implants remained entirely normal for periods of at least 9 months. It is thus quite evident that there exists a widespread resistance to the digestant action of the normal gastric content on the part of tissues and organs whose blood supply is not interfered with. It

should be emphasized that this experiment yields data only on the resistance of the tissues to the normal gastric content but not to pure gastric juice.

The experience of innumerable physicians during the past 50 years has established the fact that the free hydrochloric acid in the gastric content aspirated 1 hour after the ingestion of an Ewald meal varies between 30 and 60 clinical units in the case of normal individuals. Data obtained by the method of fractional gastric analysis advocated by Reh-fum and his associates have in general confirmed this belief. On the other hand, it has been equally well established that the concentration of free acid in pure gastric juice, such as may be obtained from isolated portions of the stomach as in the experiments of Heidenhain and Pawlow is much greater than this. The average free hydrochloric acid in the uncontaminated gastric secretion yielded by the completely isolated dog's stomach in the experiments of Dragstedt and Ellis (1930) varied between 0.35 and 0.49 per cent, the latter figure being by far the more common finding. These values correspond to approximately 100 and 135 clinical units. A similar figure (0.40 to 0.50 per cent free hydrochloric acid) has been given for pure unmixed gastric juice in man (Carlson, 1923).

If it be conceded that it has been difficult or impossible to demonstrate any deterrent effect on the healing of acute lesions in the stomach of experimental animals due to the corrosive chemical action of the normal gastric content the question naturally arises, may not pure gastric juice with its higher free acid exert such an effect? As a corollary to this we may perhaps profitably inquire into the factors which normally reduce the acidity of pure juice to that of the normal gastric content. Those that come readily to mind may be listed as the neutralizing effect of food and swallowed saliva, mucus secreted in the esophagus, fundus and particularly in the pyloric antrum of the stomach, fixed base secreted chiefly in the pyloric antrum, and regurgitated alkaline juices from the upper duodenum. Does a defect in this neutralizing mechanism or any part of it account for the fact that a majority of patients with duodenal



Fig 3 "Experimental Meckel's diverticulum ulcer" in the jejunum of Dog 8, Table I. The opened gastric pouch is above and to the left of the ulcer. Note the large size of this ulcer, its sharp margins, and the persistence of a narrow zone of jejunal mucosa between the ulcer and the gastric mucosa.

foration of an intestinal ulcer, 6 were sacrificed when they became markedly cachectic while the 5 remaining were in excellent condition at the time they were etherized for examination. Seventeen of the 10 animals had developed large typical chronic ulcers in the intestine adjacent to the anastomosis with the gastric pouch. In the cases in which the isolated gastric pouch was implanted into the ileum (6 dogs), chronic ulcers appeared in all an incidence of 100 per cent, whereas when the implantation was made in the jejunum even though a much larger pouch was used the incidence of ulcer was less (11 ulcers in 13 animals operated upon or 85 per cent). In many cases (roughly $\frac{1}{3}$ of the total) the ulcer seemed to have little deleterious effect upon the general condition of the animal until a sudden perforation or exploratory laparotomy revealed its presence. The shortest time elapsing between the date of operation and discovery of the ulcer was 14 days, the longest 160 days, and the average, 67 days.

It is significant that the ulcers always developed in the intestinal wall adjacent to the line of union with the gastric mucosa (Figs 2 and 3). In most cases a narrow line of intestinal mucosa was visible between the ulcer and the nearest gastric mucosa. The latter was never involved. The ulcers presented the same clean, punched-out 'digested' appearance characteristic of the lesion in man. Their size was often enormous and in several a crater large enough to contain an average size hen's egg was present. The floor of such an ulcer was composed of hyper-

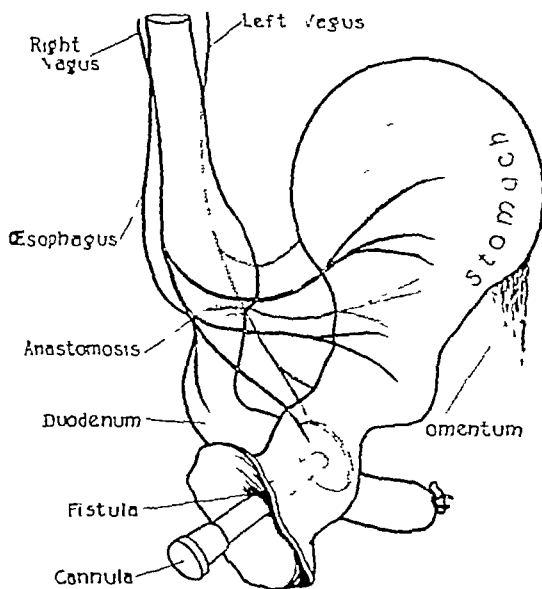


Fig 4. Diagram showing the method of preparation of the isolated stomach with vagus innervation intact. (From Dragstedt and Ellis, *Am J Physiol*, 1930, xciii, 407.)

plastic fibrous connective tissue, the remains of an inflamed indurated omentum, loops of neighboring intestine, mesentery, and in some cases organs such as the pancreas or liver. All were combined to form a large indurated inflammatory mass, requiring very careful dissection.

Microscopic examination of the intestinal mucosa in the immediate neighborhood of the ulcer presented evidence of inflammation, such as round cell infiltration suggestive of the so called Konjetzny gastritis.

The successful production of chronic perforating ulcer in the ileum of dogs under conditions resembling those in the Meckel's diverticulum ulcer in man indicates that the susceptibility of the two species to the development of this disease may not be greatly different under comparable conditions. It seems probable that we may disregard the factor of operative trauma as of any great significance in the genesis of the experimental ulcer. In a few cases the region of the anastomoses was examined at a second laparotomy from 7 to 14 days after the first operation, and in each case healing was complete or progressing satisfactorily without evidence of ulcer. Further-

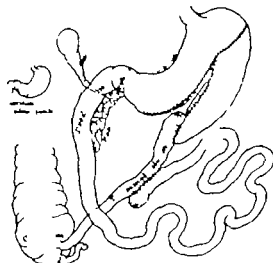


Fig. 1 Diagram showing the method of implantation of the ileo cecum into the ileum for the experimental production of Meckel's diverticulum ulcer.

This fact suggests that the ileal mucosa is more susceptible to the chemical action of gastric juice than is gastric mucosa, a point to be elaborated upon later in the discussion. The ulcer appears early in life, usually within the first 18 months, and repeated hemorrhages and occasionally perforation occur.

Because of the theoretical importance of these clinical observations and the possibility that the mucous membrane of the dog might behave somewhat differently we have at the suggestion of Dr. D. B. Phemister performed experiments designed to imitate as far as possible the situation found in Meckel's diverticulum ulcer.¹

Experimental procedure. Healthy dogs were secured and all operations were performed under complete ether anesthesia with the usual aseptic precautions. A small Pawlow pouch 2 by 3 by 8 centimeters, was made from the greater curvature of the stomach in the region of the fundus. A segment of ileum about 30 cubic centimeters proximal to the ileocecal valve was then selected, the intestine divided and the distal ileum united to the open end of the Pawlow pouch. The continuity of the intestine was then re-



Fig. 2 Experimental Meckel's diverticulum ulcer of the ileum in Dog 4, Table I. The gastric pouch is to the right of the picture. A probe protrudes from the opening of this pouch in the ileum. Note the large size of the ulcer and its proximity to the gastric mucosa.

established by anastomosing the proximal ileum to the distal intestine about 15 centimeters below its attachment to the gastric pouch (Fig. 1). Particular care was taken not to bruise the tissue or to damage its blood supply. No clamps were applied and only chronic catgut (No. 00) was used for the anastomoses. In a few of the experiments a pouch, the nervous connections of which had been first severed (Heidenhain pouch) was used for anastomosis with the lower intestine. After the results of these experiments were determined the operations were repeated on other animals, but in this case a very large Pawlow pouch was made (approximately 1/5 to 1/3 of the entire stomach) and its open end anastomosed to different regions of the jejunum, in some cases as far proximal as the ligament of Treitz.

The animals recovered from the operations promptly. They were given saline intravenously but nothing by mouth for the first 4 to 5 days. Following this they were given the regular stock diet of the laboratory consisting of ground meat, bread, carrots, and other vegetables and were fed once a day. Those that survived for as long as 2 to 3 months were usually subjected to a second laparotomy and the condition of the intestine determined by inspection.

The results of the experiments are summarized in Table I. Of the 19 animals operated upon 8 died of peritonitis following per-

¹ A preliminary report of this work was published in the *Proceedings of the Society for Experimental Biology and Medicine*, 1931, 27: 400.

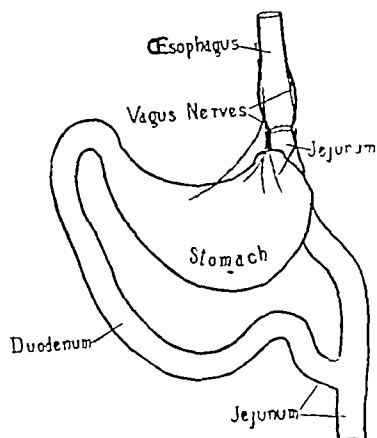


Fig 8 Diagram showing the type of preparation used to determine the effect of gastric secretion in the stomach empty of food on the occurrence of ulceration of the intact gastric mucosa

essential difference in the two experiments lies probably in the removal of the entire neutralizing mechanism in the latter case so that the intestinal mucosa is exposed to the acid pepsin concentration of *pure fundus secretion* whereas when the intestine is implanted into the stomach it is exposed only to the acid-pepsin concentration of the usual gastric content, i e , after dilution and partial neutralization by the mechanisms suggested in the introduction

b *Occurrence of chronic perforating ulcer in the isolated stomach* It is noteworthy in the experiments described in the preceding section that in no instance did ulcers appear in the

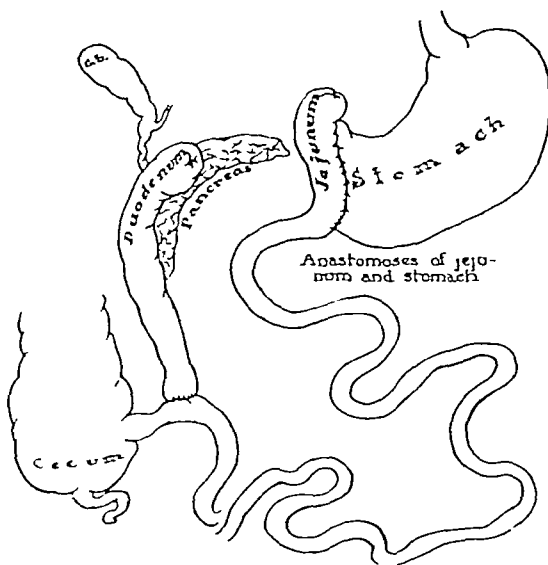


Fig 9 Diagram showing the author's modification of the experiment of Mann for the production of jejunal ulcer by "surgical duodenal drainage" In spite of the resection of the pyloric antrum and the large anastomosis, chronic ulcers developed in 100 per cent of cases

gastric pouch, whereas in a very large proportion of cases, large, chronic, progressive ulcers developed in the mucosa of the ileum and jejunum The operative trauma to the gastric mucosa was obviously greater and it must have been exposed to as high or a higher concentration of pepsin hydrochloric acid than the intestine These facts suggest that the

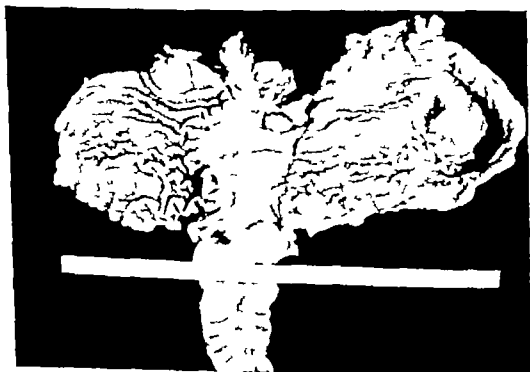


Fig 10 Photograph showing the formation of a jejunal ulcer following the type of operation illustrated in Figure 9



Fig 11 Photograph showing the formation of a small jejunal ulcer near the suture line and three small gastric ulcers following an operation as in Figure 9 These gastric ulcers are very unusual



Fig. 5. Drawing showing the formation of large chronic progressive ulcer in the isolated stomach

more, the almost invariable persistence of a strip of intestinal mucosa between the ulcer and the line of anastomosis suggests that the probable vascular damage to the intestine as a result of incision and subsequent suture was not of paramount importance in the ulcer formation. In man of course, there can be no question of trauma or vascular injury and we must attribute the ulcer to the destructive effect of the gastric juice. In both cases it is probably of considerable importance that the gastric juice enters an ileum empty of food or secretion and consequently its free acid is little reduced. Secretion of gastric juice in the Pawlow pouch begins with the entrance of food in the mouth as a result of reflex stimulation



Fig. 7. Photograph showing extensive digestion of the mesentery following rupture of chronic ulcer in large Pawlow pouch permitting several branched cubic centimeters of very acid gastric juices to escape into the peritoneal cavity



Fig. 6. Chronic perforating ulcer occurring spontaneously in very large Pawlow pouch. The mucosa of the lesser curvature of *M. gastricae* shown below to the right and that of the first part of the duodenum to the left are normal.

of secretory nerves in the vagi and accordingly its pepsin hydrochloric acid comes in contact with the mucosa of the ileum long before food reaches this level and could possibly exert a neutralizing effect. Even in the experiments with the Heldenhain pouches and in the clinical cases it is likely that the hormone stimulation of the gastric mucosa produces a secretion before food reaches the ileum. At all events the production of intestinal ulcers by implants of gastric mucosa, completely separated from all connections with the central nervous system, speaks volumes against the rather fanciful idea that the latter plays a rôle in the proximal cause of the lesions. As noted above the incidence of ulcer in the intestine was 100 per cent when the gastric pouch (with or without nerves) was implanted into the ileum but only 85 per cent when the implantation was made in the jejunum. This may be interpreted to indicate a greater resistance on the part of the jejunal mucosa or it may be due to the earlier appearance of the chyme and neutralizing secretions of the upper duodenum.

The absence of ulcer formation in segments of jejunum or ileum implanted into the stomach as in the experiments of Dragstedt and Vaughn (1924) and the uniform occurrence of such lesions in the intestine when segments of stomach are implanted as in the experiments described are striking and at first glance contradictory phenomena. The



Fig 14. Photograph showing a chronic perforating jejunal ulcer in Dog 5, Table II, after an operation as illustrated in Figure 12. The valve has been partly withdrawn to show its shape and condition after having been in place 54 days. Its previous location is indicated by the tag of omentum adherent to the intestine about 18 centimeters from the ulcer.

the physiology of gastric secretion. To our knowledge no one has to date reported the spontaneous occurrence of an ulcer in such a pouch. As noted in the preceding section, this may be due to the fact that the gastric juice is commonly promptly drained away by the fistula and so does not remain in contact with the gastric mucosa for any appreciable length of time. However, in 1917, one of us (L R D) tried to prepare Pawlow pouches in dogs in such a way that the gastric secretion should be retained in the pouch, by implanting the fistulous opening in the skin of the lateral abdominal wall, instead of on the ventral surface. Spontaneous ulcers did not occur in these pouches and acute lesions produced by silver nitrate seemed to heal as readily as in control dogs where the accessory stomach was continually drained. An examination of the data respecting the acidity of the gastric juice from these pouches, however, suggests an explanation for these negative results. The free hydrochloric acid varied between 0.00 and 0.109 per cent with an average of about 0.045 per cent. This is far below the acidity of the juice from the isolated entire stomach (as noted above) and is within the range of acidity of the normal gastric content which Dragstedt and Vaughn (1924) found to be relatively innocuous even to the exposed spleen. By means of a technique modified considerably from that given by Pawlow, we have been able to construct an isolated accessory stomach



Fig 15. Photograph showing a large perforating jejunal ulcer in Dog 7, Table II, after an operation as illustrated in Figure 12. The edge of the ulcer is exactly at the line of anastomosis with the stomach. The floor of the ulcer is made up of liver, which is partially eroded.

containing from $\frac{2}{3}$ to $\frac{3}{4}$ of the fundus, leaving only a channel along the lesser curvature not larger in diameter than the duodenum below. Such a large accessory stomach may secrete from 800 to 2,800 cubic centimeters of gastric juice in 24 hours with a free acidity ranging between 0.25 and 0.49 per cent (Dragstedt and Ellis, 1930). In one such preparation a large chronic ulcer (see Fig 6) formed in the Pawlow pouch and ruptured 4 months after the original operation, producing a fatal peritonitis. A striking feature of such a peritonitis which results in the liberation of an exceedingly active secretion into the general peritoneal cavity is illustrated in Figure 7. This extensive widespread digestion of the mesentery and omentum is not seen following the escape of the usual gastric or duodenal content. The occurrence of a chronic progressive ulcer in the isolated accessory stomach and the complete absence of any comparable lesion in the small channel left along the lesser curvature, the gastric canal or *magenstrasse*, is very instructive. The mucous membrane of this lateral gastric canal has withstood the mechanical effect of swallowed food and the motility of gastric digestion and in spite of this the long suture line has healed and remained so. In the accessory stomach on the other hand no food has entered and the mechanical effect of coarse food particles massaged into the mucosa by digestion peristalsis has been entirely absent. Nevertheless an ulcer formed, became chronic and progressive and finally perforated. The most evident difference between the two portions

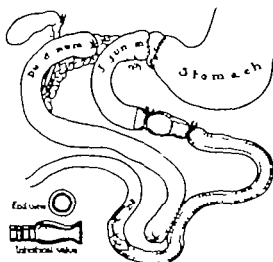


Fig. 2. Diagram illustrating the author's method for producing jejunal ulcers by surgical duodenal drainage with high implantation of the duodenum. Regurgitation of duodenal juices in the jejunum is prevented by the valve.

gastric mucosa does actually possess a greater resistance to the digestant action of pure gastric juice than is present in the mucosa of the intestine lower down. If pure, unneutralized gastric juice is able to produce a chronic ulcer in the stomach, it would appear that the optimum conditions for such a lesion should exist in the so called isolated stomach. Frémont (1895) made a brief allusion to some experiments performed on dogs in which he had isolated the stomach, suturing the duodenum to the esophagus and collecting the gastric secretion by means of a fistula. Inasmuch as he states that such a stomach to which the vagi have been cut secretes a fluid containing no acid and is non-digestive we may question whether he actually secured a good preparation. Lim Ivy and McCarthy (1925) however isolated the entire stomach of dogs using the method described by Frémont, and Ivy has kept such animals alive for a number of years. Although the vagus nerves to these isolated stomachs have been cut they secrete a highly acid proteolytic juice. In no case has Ivy (1931) observed an ulcer in such a stomach. It should be noted however that in all these experiments the gastric juice has been permitted to flow away from the stomach by way of a fistula almost

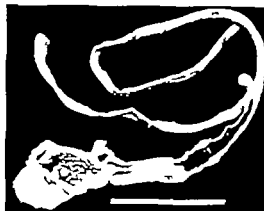


Fig. 3. Photograph showing typical jejunal ulcers in Dog Table II, after operation illustrated in Figure 2. In this case an end-to-side anastomosis was made between the stomach and jejunum.

as soon as it is secreted so that there is at no time a prolonged contact of the active juice with the mucosa. It is likely that this fact is of decisive importance. L. R. Dragstedt and Ellis (1930) described a method for preparing an isolated stomach in the dog leaving the vagus innervation intact and making a fistula with a metal cannula by means of which it is possible to retain pure gastric juice in the stomach at will (see Fig. 4). During the past 5 years a number of such animals have been kept in the laboratory. For the most part gastric juice has been permitted to flow out of the fistula into a collecting rubber bag so that to date the full advantage of the method for determining the effect of pure gastric juice on gastric mucosa has not been obtained. However in one case a large typical chronic ulcer (see Fig. 5) was found in the isolated stomach. As will be noted from the illustration this lesion occurred close to the entrance of the cannula so that we cannot exclude this mechanical factor in the etiology. However when such a cannula is placed in the normal intact stomach or intestine it has never produced such a defect.

c. Occurrence of a chronic perforating ulcer in a Pawlow accessory stomach. A small isolated accessory stomach made from the fundus after the method of Pawlow has been widely used in many physiological laboratories during the past 30 years for the study of

and pepsin concentration of the secretion of the gastric fundus should be the diluting and neutralizing effect of the food. Most of the proteins are capable of combining with hydrochloric acid and the products of pepsin hydrochloric acid digestion exert an inhibitory effect on the enzyme itself. It is quite probable that a part at least of the favorable result from the regimen of frequent feeding in the medical management of ulcer is due to this factor. The question is of definite practical importance because from time to time there appears in the literature a suggestion that ulcer patients be treated by duodenal tube feeding or the administration of food by means of a jejunostomy. The idea that such a method puts the stomach at rest is quite false so far as its secretory function is concerned. It has been repeatedly demonstrated in the experimental animal that the introduction of food in the duodenum or jejunum produces a copious secretion of gastric juice. The type of isolated stomach described by Dragstedt and Ellis was found to secrete as much as 2,800 cubic centimeters of gastric juice of high acidity in 24 hours when food passed directly from the oesophagus into the duodenum. Reasoning from this kind of evidence, duodenal tube feeding might be expected to permit the accumulation in the stomach of a gastric content of much higher free acidity than would occur when food is given by mouth, and such a method should be more apt to produce an ulcer in the stomach than to cure one. It is not practicable to feed a dog by duodenal tube, so recourse must be had to other types of experiments which reproduce the desired situation so far as possible.

Silbermann (1927) has reported the occurrence of ulcers in the stomach and duodenum of dogs subjected to repeated "sham feeding" experiments. A double oesophagostomy was done on 23 dogs and feeding was accomplished through the peripheral oesophageal opening. These dogs were allowed to eat from 40 to 60 minutes three times a day, the swallowed food escaping to the outside via the fistula. Ulcers developed in every case in from 14 to 49 days.

Buechner (1928) reported the occurrence of ulcers in the stomach of rats following the repeated injection of histamine. Buerkle-de la

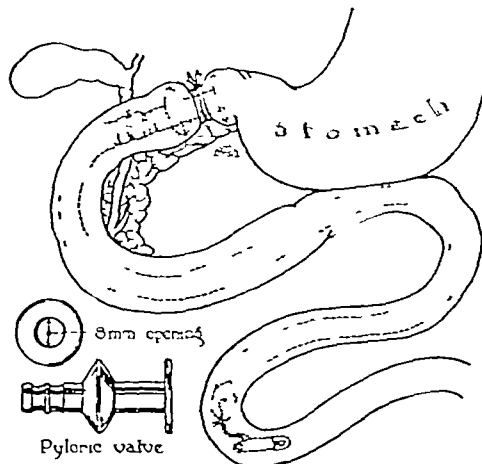


Fig. 18. Diagram illustrating the use of the valve to prevent regurgitation of duodenal juices into the stomach.

Camp (1929) found that the healing of acute ulcers produced by the injection of silver nitrate beneath the gastric mucosa of dogs was markedly delayed by the repeated injection of histamine. Both the ulcers occurring after sham feeding in dogs and those in rats injected with histamine have been attributed to the secretion of gastric juice in a stomach empty of food. The latter experiments are vitiated somewhat by the discovery of Hoelzel and Da Costa (1931) that ulcers may be produced in the pro-stomach of rats merely by protein restriction, a finding which emphasizes the necessity of adequate nutritional controls in all such work.

We have induced gastric secretion in the empty stomach by two methods but have not to date observed the production of ulcer in the previously intact gastric mucosa. The first observations were made on 3 adult dogs provided with a total oesophageal fistula and a gastrostomy. These animals were in excellent physical condition. When offered food they ate eagerly, but the partially masticated and ensalivated food escaped by way of the oesophageal fistula when swallowed, instead of passing into the stomach. Sham feeding of this type has been shown to produce a copious secretion of gastric juice as a result of reflex stimulation of secretory nerves reaching the stomach in the vagi. All 3 dogs were given such sham meals daily for a period of a month,

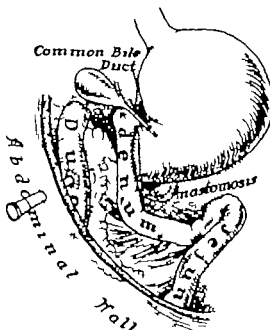


Fig. 6 Diagrammatic illustration of the type of pancreatic fistula used. The pancreatic ducts empty into the isolated closed segment of the upper duodenum and an external fistula has been made of this pancreatic duodenal pouch with special gold plated cannula.

of the stomach seems to lie in the probable acidity and pepsin concentration of their respective contents. In the one case the isolated pouch the free acidity and pepsin concentration was very high while in the other it is probable that its content would fall within the range of acidity and pepsin concentration of the stomach of the normal unoperated animal.

RELATION OF SWALLOWED SALIVA TO THE GENESIS OF GASTRIC ULCER

In the preceding section experimental evidence has been submitted indicating that the pure undiluted gastric juice may by its chemical action produce a chronic progressive ulcer in the mucosa of the ileum, jejunum, or stomach. We realize of course that only under the highly artificial conditions of these experiments does the mucosa of the alimentary tract become exposed to such pure gastric secretion and it is our present purpose to inquire into the relative significance of the

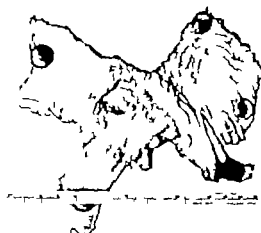


Fig. 7 Photograph showing large chronic duodenal ulcer in a dog, discovered at autopsy 3 months after the production of a pancreatic fistula as illustrated in Figure 6.

various factors which operate to reduce the acidity and pepsin concentration to that of the usual gastric content. In this connection it seems clear that the neutralizing effect of swallowed saliva plays at most a very minor rôle. Swanson (1917) demonstrated that removal of the salivary glands does not appreciably affect the volume or acidity of gastric secretion from a Pawlow pouch. Since he was interested primarily in the possibility of a hormone from the salivary glands affecting gastric secretion he made no analyses of the acidity of the contents of the main stomach. No ulcers, however, were found in these animals. We are indebted to Dr. Mary Montgomery for our observations on 3 dogs provided with a total esophageal fistula in the neck and a gastrostomy. All of the swallowed saliva, of course, escaped by the fistula and the animal was fed with an artificial pabulum administered by way of the opening in the stomach. These dogs were kept in good nutrition for about a year and suffered no ill effects from the loss of saliva. No evidence of ulcer or erosion was found in the stomach or duodenum on postmortem examination.

ABSENCE OF THE NEUTRALIZING EFFECT OF SWALLOWED FOOD IN THE GENESIS OF ULCER

1 priori it would appear that the most important single factor in reducing the acidity

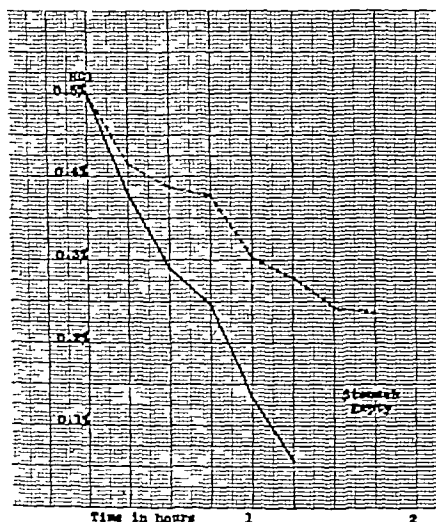


Fig 21 Curves showing the neutralization of 200 cubic centimeters 0.5 per cent hydrochloric acid placed into the empty stomach before and after the introduction of the pyloric valve to prevent duodenal regurgitation. The broken line represents the postoperative results. Bile was present in the pre-operative aspirations consistently after the first $\frac{1}{2}$ to 1 hour, but never after the valve was put in. Dog 12.

more data are necessary before any final conclusions can be drawn, but the absence of an ulcer in this experiment is in harmony with the evidence detailed in the next section which indicates the great importance of the neutralizing effect of the bile and pancreatic juice.

RELATION OF THE NEUTRALIZING EFFECT OF THE DUODENAL SECRETIONS TO THE GENESIS OF ULCER

Exalto, in 1911, reported that he tied off the pylorus in dogs, performed a gastrojejunostomy, and then drained the duodenal juices of the proximal loop into the cæcum. Jejunal ulcers formed in 6 of 10 animals operated upon in this manner. He discussed his results in the light of the relatively high percentage of jejunal ulcers following the Roux type of gastrojejunostomy, which was popular in part of Europe at that time. The surgical duodenal drainage experiments of Mann and his associates, Williamson, Morton and McCann have been especially fruitful in demonstrating the significance of the neutralizing effect of the duodenal secretions in the cause of ulcer. This work has been widely confirmed in this coun-

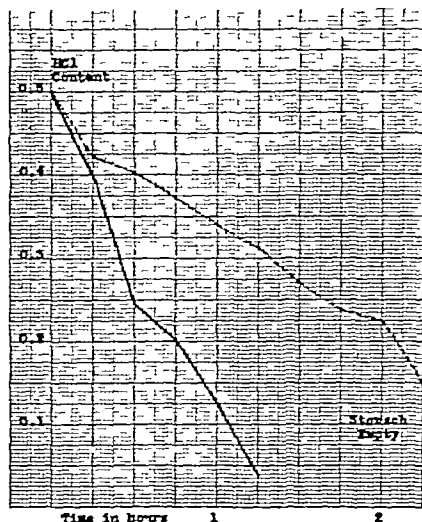


Fig 22 Curves showing the neutralization of 200 cubic centimeters 0.5 per cent hydrochloric acid placed into the empty stomach before and after the introduction of the pyloric valve to prevent duodenal regurgitation. The broken line represents the postoperative results. Bile was present in the pre-operative aspirations consistently after the first $\frac{1}{2}$ to 1 hour, but never after the valve was put in. Dog 13.

try and later by Weiss and Hubster (1930) in Europe. The experiments discussed below afford further evidence concerning the significance of this neutralization of gastric chyme in the duodenum and also regarding the possible regurgitation of duodenal secretions into the stomach.

In one of the early procedures employed by Mann and his associates (1923) in their study of ulcer the pylorus was cut across and the duodenal end infolded and closed. The jejunum was then divided just distal to the duodenojejunal flexure, the lower end united to the pyloric end of the stomach by end-to-end suture, and the proximal jejunum implanted into the ileum a short distance above the ileocecal valve. A very high percentage of animals operated upon in this way developed chronic progressive ulcers in the jejunum a short distance from the line of anastomosis with the stomach. We have confirmed this observation. In repeating the experiment, however, we were impressed by the narrow lumen at the anastomosis and the great thickness of the musculature of the pyloric antrum. Both factors obviously might

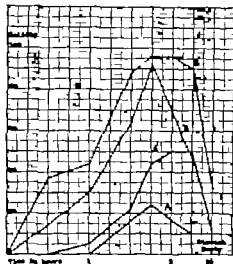


Fig. 9. Curves illustrating the effect of preventing duodenal regurgitation on the acidity of the gastric content after a test meal of meat and water. The uninterrupted lines (A and A') represent free acidity; the broken lines (B and B') total acidity. A and B are pre-operative, A' and B' postoperative curves. Dog.

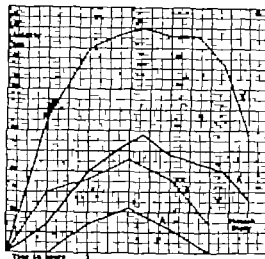


Fig. 10. Curves illustrating the effect of preventing duodenal regurgitation on the acidity of the gastric content after test meal of meat and water. The uninterrupted lines (A and A') represent free acidity; the broken lines (B and B') total acidity. A and B are pre-operative, A' and B' postoperative curves. Dog.

at the end of which time they were sacrificed and the stomach and duodenum carefully examined. No ulcers were found. These experiments, while decidedly limited in number suggest that nervous or "appetite" gastric juice does not readily produce a lesion in the empty stomach.

We appreciate of course that this nervous stimulation of gastric secretion is only one phase of the normal mechanism and that perhaps the larger share of the total volume of juice produced is due to the stimulating effect of gastrin bodies elaborated as a result of the presence of food in the stomach or upper intestine. In the following preparation (Fig. 8) we have attempted to provide for the secretion of gastric juice in the empty stomach with both nervous and humoral stimulation and with the normal connections with the duodenum. The stomach was cut across at the cardia, care being used not to injure the vagus nerves supplying the stomach. The upper end of the stomach was infolded and closed. The jejunum was then cut across about 12 inches distal to the duodenojejunal junction and the lower end of the divided jejunum brought up and anastomosed to the esophagus. The

upper end of the divided jejunum was implanted into the intestine by end-to-side anastomosis about 12 inches from the union with the esophagus. Such a preparation should provide for a maximum secretion of gastric juice into the stomach empty of food. The presence of food in the mouth with its mastication produces a reflex stimulation of the vagi resulting in the so called appetite secretion and the subsequent entrance of the swallowed food into the upper jejunum provides for the elaboration of gastric secretion and the chemical stimulation of the gastric glands. No food should enter the stomach except as it might overcome the direction of peristalsis in the jejunum. The only factors remaining to reduce the acid peptun concentration of the fundus secretion are the possible auto-neutralizing effect of gastric mucus or base secreted by the gastric mucosa and the regurgitation of alkaline secretions from the upper duodenum. We have no direct evidence that either of these factors were actually operative. Only one dog has been studied by this method to date (for 70 days) but in this animal no lesion developed in the stomach, duodenum, or jejunum. Obviously

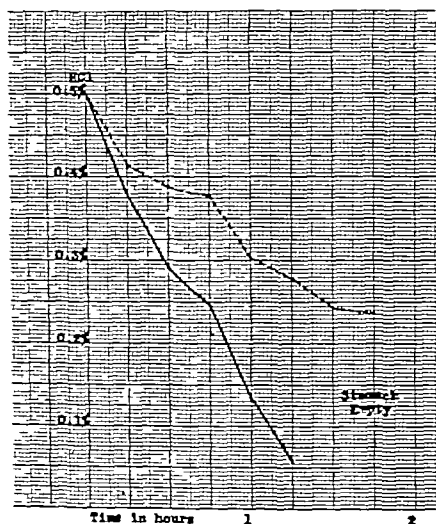


Fig 21 Curves showing the neutralization of 200 cubic centimeters 0.5 per cent hydrochloric acid placed into the empty stomach before and after the introduction of the pyloric valve to prevent duodenal regurgitation. The broken line represents the postoperative results. Bile was present in the pre-operative aspirations consistently after the first $\frac{1}{2}$ to 1 hour, but never after the valve was put in. Dog 12

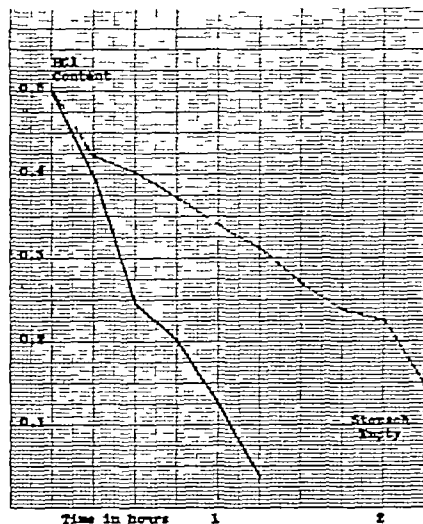


Fig 22 Curves showing the neutralization of 200 cubic centimeters 0.5 per cent hydrochloric acid placed into the empty stomach before and after the introduction of the pyloric valve to prevent duodenal regurgitation. The broken line represents the postoperative results. Bile was present in the pre-operative aspirations consistently after the first $\frac{1}{2}$ to 1 hour, but never after the valve was put in. Dog 13

more data are necessary before any final conclusions can be drawn but the absence of an ulcer in this experiment is in harmony with the evidence detailed in the next section which indicates the great importance of the neutralizing effect of the bile and pancreatic juice

RELATION OF THE NEUTRALIZING EFFECT OF THE DUODENAL SECRETIONS TO THE GENESIS OF ULCER

Lvalto in 1911, reported that he tied off the pylorus in dogs, performed a gastrojejunostomy, and then drained the duodenal juices of the proximal loop into the cæcum. Jejunal ulcers formed in 6 of 10 animals operated upon in this manner. He discussed his results in the light of the relatively high percentage of jejunal ulcers following the Roux type of gastrojejunostomy, which was popular in part of Europe at that time. The surgical duodenal drainage experiments of Mann and his associates, Williamson, Morton, and McCann, have been especially fruitful in demonstrating the significance of the neutralizing effect of the duodenal secretions in the cause of ulcer. This work has been widely confirmed in this coun-

try and later by Weiss and Hubster (1930) in Europe. The experiments discussed below afford further evidence concerning the significance of this neutralization of gastric chyme in the duodenum and also regarding the possible regurgitation of duodenal secretions into the stomach.

In one of the early procedures employed by Mann and his associates (1923) in their study of ulcer, the pylorus was cut across and the duodenal end infolded and closed. The jejunum was then divided just distal to the duodenojejunal flexure, the lower end united to the pyloric end of the stomach by end-to-end suture, and the proximal jejunum implanted into the ileum a short distance above the ileocaecal valve. A very high percentage of animals operated upon in this way developed chronic progressive ulcers in the jejunum a short distance from the line of anastomosis with the stomach. We have confirmed this observation. In repeating the experiment, however, we were impressed by the narrow lumen at the anastomosis and the great thickness of the musculature of the pyloric antrum. Both factors obviously might



Fig. 3 Photograph showing an acute gastric ulcer in control animal 72 hours after the injection of 1.5 cubic centimeters of 5 per cent silver nitrate

operate in a mechanical way to produce a mucosal lesion and prevent its healing. Mann himself recognized this point and believed that the motor drive of the stomach and the direction of the stream of gastric chyme were important in determining the site of the resulting ulcer. The following modification of Mann's experiment was devised to test the importance of these factors. Five dogs were operated upon as described except that the muscular pyloric antrum was first resected and a wide anastomosis made between the large open end of the stomach and the side of the jejunum (Fig. 9). A gastric outlet of this nature should not permit a narrow stream of acid chyme to be forcibly ejected against a single area of jejunal mucosa. However in every case (100 per cent) jejunal ulcers developed (see Figs. 10 and 11). These ulcers were small and shallow and located at the lower end of the gastro-jejunosomy. I.e. opposite the greater curvature of the stomach. They were not so deep or extensive as the ulcers following the end-to-end gastrojejunostomy possibly because the "motor drive" effect was dissipated. These experiments were completed before the similar work of Ivy and Fauley (1931) was published and confirm their findings. These investigators reported that of 11 dogs operated upon in this manner 5 developed jejunal ulcers. We may probably correctly infer then that the jejunal ulcers developing in this type of experiment are not dependent upon the "nozzle-like" effect of a narrowed pyloric orifice. We cannot, however, conclude from these experi-

ments that the removal of a local neutralizing solution is the sole pathogenic factor in the ulcer formation. Both the animals operated upon by the exact technique of Mann and by our modified method developed a rapid and progressive cachexia. Immediately after the operation all the dogs began to display a profuse watery diarrhoea which improved somewhat after a few days. The diarrhoea was usually accompanied by some loss of appetite. The weight loss was marked and progressive and many animals lost 50 per cent of their original body weight in 1 to 2 months. They all died within 3 months in spite of freedom from laboratory infections. It seems likely that death was caused by the nutritional disturbance rather than the jejunal ulcers, most of which did not perforate nor cause excessive haemorrhage. The factors in this nutritional disturbance are probably two-fold. The absence of two very important digestive secretions from the upper absorptive small intestine might be expected to interfere markedly with the digestion and absorption of food and, second, the partial failure of reabsorption of pancreatic juice and bile because of the low implantation, might be expected to result in dehydration and excessive loss of electrolytes from the blood and body fluids (Elman and McCaughan, Dragstedt, Montgomery, Matthews and Ellis). It is well recognized that cachexia produced by repeated haemorrhage or infections (Ivy 1920) or food deficiencies (Hoelzel, etc.) may operate to delay the healing of gastric lesions or induce ulcers. The cachexia is controlled by drainage of the duodenum higher into the jejunum but under these conditions ulcers do not develop in the jejunum or the stomach. This failure of ulcer formation when the duodenum is implanted into the middle or upper jejunum has been attributed by Mann to a possible regurgitation of the duodenal secretions back orally through the jejunum and neutralization of the acid chyme in the region of the gastro-jejunosomy. This interpretation seemed rather improbable to us and the following experiments were devised to test its validity. The results indicate that it is probably correct and in addition furnish further controls with regard to the significance of operative trauma

in the genesis of these "duodenal drainage jejunal ulcers"

Healthy adult dogs were secured and all operations were performed under complete ether anaesthesia and with the usual aseptic precautions. The procedure is illustrated in Figure 12. The pylorus was divided and the duodenum infolded and closed. The jejunum was then cut across just below the ligament of Treitz and the distal jejunum united to the pyloric end of the stomach by end-to-end suture. The distal end of the duodenum was implanted into the jejunum about 40 centimeters from the anastomosis with the stomach. No clamps were used in the operation. No *oo* chromic catgut was used for suture material and great care was taken not to injure the blood supply to the region of anastomosis. The animals promptly recovered from this somewhat extensive operation and remained in good condition thereafter. After a period of from 80 to 300 days, a second laparotomy was done and the region of the anastomosis between the jejunum and stomach carefully examined. In only 1 of the 21 dogs operated upon in this manner was a jejunal ulcer found, a striking contrast to the high incidence of such ulcers when the duodenal juices were drained into the lower ileum. To determine if this freedom from ulcer formation was due to the regurgitation of alkaline pancreatic juice and bile to the region of the gastrojejunostomy, a specially devised valve was then introduced into the segment of jejunum between the two anastomoses (see Fig. 12). This valve was so constructed as to permit of the flow of intestinal content only in one direction and so effectually prevented any regurgitation. The valve consisted essentially of an aluminum ring to which was attached a long piece (40 centimeters) of easily collapsible rubber tubing (Penrose). The ring was held in place in the jejunum by means of two tapes encircling the bowel, one being placed around the ring and one just below it. The inside diameter of the ring varied from 0.9 to 1.2 centimeters which was found adequate to prevent obstruction in most instances. Following the introduction of the valve at this second operation, the diet was restricted to finely divided and liquid foods



Fig. 24. Photograph showing a chronic gastric ulcer in Dog 6, 30 days after the injection of silver nitrate, where duodenal regurgitation has been prevented by a valve in the pylorus.

The postoperative course varied somewhat. Five of the animals died of peritonitis due to a transection of the jejunum because of too tight a ligature about the aluminum ring. In six the ligatures were too loose, and the valve was passed with the feces. Ten of the animals retained the valves and of these 6 developed progressive ulcers in the jejunum. The data are summarized in Table II.

TABLE II—INCIDENCE OF JEJUNAL ULCER AFTER THE OPERATION ILLUSTRATED IN FIGURE 12

Dog No	Time between first and second operations	No days after second operation when death occurred	Autopsy findings
1	None	61	Chronic ulcer 2 cm. in diameter. Small perforation.
2	170 days	63	No ulcer.
3	173 days	42	No ulcer. dog died of hemorrhage from erosion by valve into intestinal wall.
4	97 days	157	Chronic ulcer 1.5 cm. in diameter and 0.3 cm. deep. Perforated.
5	96 days	54	Chronic ulcer 1 cm. x 0.6 cm. Perforated.
6	85 days	12	Acute ulcer 0.4 cm. in diameter. Perforated.
7	81 days	65	Chronic ulcer very large and deep. Base made of liver. Perforated.
8	101 days	46	No ulcer. Animal died of obstruction of valve by hairball.
9	77 days	16	No ulcer. Animal died of obstruction of valve by hairball.
10	70 days	81	Chronic ulcer 2 x 1 cm. Perforated.

*In Dog 1 all the operative work was done in one stage.

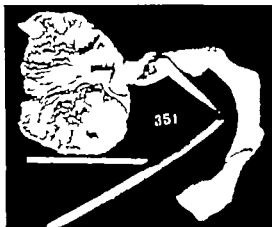


Fig. 35. Photograph showing chronic ulcer in tricuspid valve of duodenum in the gastric wall where duodenal regurgitation has been prevented by valve in the pylorus. The metal screw was placed inside the valve to indicate its position and the duodenum has been slit open to show the rubber tubing.

The photographs in Figures 13, 14, and 15 illustrate quite well the large size of these ulcers and their characteristic punched-out margins. It is significant that in each case the ulcer developed near the anastomosis with the stomach and at some distance from the valve. It is accordingly improbable that the valve exerted any local irritating effect of consequence in the genesis of the lesion. There was always a considerable inflammatory reaction around the valve. Numerous adhesions were present and the omentum was greatly thickened where it had been wrapped around the jejunum. The dogs remained in good physical condition following the second operation except those that died accidentally as noted in Table II (i.e. Dogs 3, 8, 9). Each of the dogs (Dogs 2, 3, 8, and 9) which did not develop ulcer died from an accidental cause. It is possible that the incidence of ulcer formation might have been higher had it been possible to keep all the animals alive under the conditions of the experiment.

The data obtained in these experiments are instructive in that they rule out cachexia and surgical trauma as important factors in the genesis of the jejunal ulcer of the Mann experiment. The high implantation of the duodenal loop caused much less disturbance

in digestion and absorption than when the bile and pancreatic juice passed into the lower ileum. The long interval between the first operation and the introduction of the valve permitted the anastomosis between the stomach and duodenum to become well healed and demonstrated that the trauma of operation and the mechanical factors of digestion operating were insufficient to produce a jejunal ulcer. The development of such an ulcer in a relatively high percentage of cases after the introduction of the valve which so far as we can see acts only to prevent a regurgitation of the alkaline duodenal juices, is to our mind very strong evidence that this failure of neutralization of the acid gastric chyme is the factor of prime importance in such ulcer formation. The efficiency of the valves in preventing regurgitation of intestinal content is indicated by the following evidence. After the first operation consisting of a gastro-jejunoostomy with high implantation of the duodenal loop, bile was frequently found in the gastric content but never after the introduction of the valve. Curiously enough, however, the acidity of the gastric content as determined by test meals was but little affected by the valve. At autopsy the jejunal mucosa above the valve was never bile-stained and water introduced into the intestine below the valve could not be forced by it into the upper jejunum.

OCCURRENCE OF CHRONIC PROGRESSIVE DUODENAL ULCER IN DOGS WITH PANCREATIC FISTULA

In 1930 Dragstedt, Montgomery and Hills described a new method for the construction of a permanent total pancreatic fistula in the dog. The upper portion of the duodenum into which the various pancreatic ducts empty was converted into a closed sac and connected to the exterior by means of a special gold-plated cannula. The common bile duct was then implanted into the stomach and the continuity of the alimentary tract re-established as indicated in the diagram in Figure 16. The dogs readily recover from this somewhat extensive operation, and if care is taken to replace the minerals lost in the pancreatic juice by the daily intravenous

administration of salt solution, they may be kept in fairly good nutrition in the laboratory for long periods. We have prepared a number of such animals in connection with other work. They all developed one, or more, very large chronic ulcers in the duodenum near the anastomosis with the stomach (Fig 17). Several of these caused death from hæmorrhage or perforation. These observations confirm the findings of Elman (1931)

It is significant that we have been able to prevent this ulcer formation for periods as long as 6 months by the oral administration of calcium carbonate, sodium bicarbonate, or finely ground bone meal. In one such animal preserved in good nutrition for 5 months by this neutralization therapy, an acute ulcer developed in the duodenum and caused a fatal hæmorrhage 3 days after the therapy was stopped.

EFFECT OF THE PREVENTION OF DUODENAL REGURGITATION INTO THE STOMACH

The suggestion that the acidity of the fundus secretion of the stomach was under normal conditions partially neutralized by the regurgitation of duodenal secretions, was first elaborated by Boldyreff about 30 years ago. He claimed that such a regurgitation invariably occurred when the acidity of the stomach content approached that of pure gastric juice. For example, 200 cubic centimeters of 0.5 per cent hydrochloric acid placed in the empty stomach of the dog and removed 1 hour later was found to have an acidity of only 0.2 to 0.15 per cent and to contain both bile and pancreatic enzymes. If the pancreatic ducts were previously ligated or the pancreatic juice removed by means of a fistula, the neutralization proceeded so slowly that little change was noted even after several hours. Pancreatic juice was considered more effective in this neutralization than the other duodenal secretions combined. Elman has recently confirmed and extended these findings of Boldyreff and has in addition reported the following highly significant observation. Three hundred cubic centimeters of 0.5 per cent hydrochloric acid introduced into the empty stomach of a patient suffering from an ulcer near the pylorus was much more slowly neutralized

than in the normal human stomach. This he attributed to decreased duodenal regurgitation because of pylorospasm. A number of observers have noted the infrequent appearance of bile in the gastric content of patients with pyloric ulcer as compared with the normal.

The development of a valve similar to the one described in the preceding section which permits the passage of intestinal content in only one direction has made it possible for us to study the effect of preventing duodenal regurgitation on the acidity of the gastric content, on the healing of artificial wounds in the gastric mucosa, and on the production of ulcers in implants of intestinal mucosa in the gastric wall. For this work short tubes of gold-plated brass or aluminum were used, to one end of which a piece of thin walled collapsible rubber tubing (Penrose) about 40 centimeters in length was attached. The valve was placed in the pylorus as indicated in Figure 18, the rubber tubing extending into the lower duodenum. A heavy linen ligature placed about the pylorus was found sufficient to hold the valve in place. After some experimentation it was found that valves with an inside diameter of 8 millimeters were large enough to permit of normal emptying of the stomach.

Healthy adult dogs of average size (10 to 14 kilograms) were selected and all operations were performed under complete ether anaesthesia and with the usual aseptic precautions. An incision was made in the anterior wall of the stomach about 10 centimeters from the pylorus and the valve fixed in place as indicated above. At the same time an acute ulcer was produced on the posterior wall of the stomach by injecting 1.5 cubic centimeters of 5 per cent solution of silver nitrate just beneath the mucosa. The gastrotomy wound was closed with catgut. Intravenous fluids were given for 3 or 4 days after the operation and thereafter only liquids and finely divided food by mouth in order to prevent obstruction through possible clogging of the valve. Repeated gastric analyses were made both before and at varying periods after the operation.

a *Effect of preventing duodenal regurgitation on the acidity of the gastric content.* For this determination a test meal similar to the

one described by McCann (1929) was employed. The animals were given no food for 24 hours before the examination and the stomach was then proved to be empty by lavage and aspiration. A meal of 80 grams of finely ground raw lean beef and 350 cubic centimeters of water were given and fractions secured by aspiration every 30 to 30 minutes until the stomach was empty. The curves in Figures 19 and 20 taken from 3 typical experiments prove that the prevention of duodenal regurgitation has raised both the free and total acidity of the gastric content. It will be noted that not only are the free and total acidity higher after the operation than before, but the height of the acidity is sustained longer than before operation. Occasionally in a pre-operative fractional analysis, one sample of gastric content in a series might show an unusually high free acidity. In several such cases the succeeding sample was slightly bile colored and of decidedly lower acidity. In these experiments before operation bile was usually not present except toward the end of the experiment. In no case was bile found in the stomach after the introduction of the valve.

b *Effect of preventing duodenal regurgitation on the neutralization of acid introduced into the stomach.* In these experiments no food was given for 24 hours and the stomach proved to be empty by lavage and aspiration as before. Two hundred cubic centimeters of 0.5 per cent hydrochloric acid was then placed in the stomach and fractions removed every 15 minutes for examination until the stomach was empty. The curves in Figures 21 and 22 taken from two representative experiments indicate that the acid introduced into the stomach is rapidly neutralized in part at least in the normal animal but only much more slowly in the same animal after duodenal regurgitation has been prevented. These findings confirm the observations of Boldyreff many years ago.

c. *Effect of preventing duodenal regurgitation on the emptying time of the stomach.* The emptying time of the stomach was determined by a method similar to the one described by Ivy and Faulk (1929). Twenty four hours after the last feeding the stomach was proved to be empty by lavage and aspiration. A meal

consisting of 80 grams of ground lean beef 40 grams of white bread 60 grams of barium sulphate, and 300 cubic centimeters of water mixed together to form a thick paste was then given and eaten readily. Fluoroscopic examination was made immediately and thereafter every 30 minutes until the stomach was empty. The examinations were made with the dogs lying back down and held in position by a frame especially devised for this purpose. Both the gastric analyses and the emptying time tests were repeated many times on the same animal until the results became consistent. Several weeks were usually required for training. At first the animals were frightened and struggled somewhat but in a short time became gentle and even co-operative, apparently little disturbed by the experiments. During the early period 6 to 8 hours were frequently required before the stomach became empty whereas, after training the same animal emptied the stomach quite regularly in 4 to 4½ hours. For 2 weeks after the introduction of the valve in the pylorus the emptying time was prolonged to 12 hours or more. After this time, however the stomach seemed to become adapted to the presence of the foreign body and the emptying time ranged between 4½ and 5½ hours, or only slightly more than before operation. It is probable that the valves produced an actual slight pyloric stenosis, since the gastric peristalsis was noticeably more vigorous than before operation. The ulcers (see below) were not detected by fluoroscopic examination.

d *Effect of preventing duodenal regurgitation on the healing of acute gastric ulcers.* After control observations had been made on the gastric response to a test meal and to the Boldyreff acid meal as already described, the animals in this series were operated upon and the special valve placed in the pylorus. At the same time an acute ulcer was produced on the posterior wall of the stomach by injecting 15 cubic centimeters of 5 per cent silver nitrate beneath the mucosa. Control animals were injected in a similar way with the same amount of silver nitrate. The injection produced an immediate local necrosis the slough being digested away in about 48 hours, leaving a sharply circumscribed superficial

ulcer (Fig 23) In the control animals these acute lesions invariably healed in 15 to 18 days, a confirmation of the observations of Friedman and Hamburger (1914) and L R Dragstedt (1917) In 13 animals in which duodenal regurgitation was prevented by the valve, healing of the acute lesion was delayed in 6 cases The data are summarized in Table III Three of the animals were sacrificed after 25, 26, and 32 days, respectively, and of these one ulcer was still present (25 days), the others being healed Six animals were sacrificed after 30 days, and, in these, 3 ulcers were still present (Dogs 5, 6, and 9), the remainder being healed Four were examined

TABLE III—EFFECT OF PREVENTING REGURGITATION ON HEALING

Summary of the data indicating the effect of preventing duodenal regurgitation on the healing of acute lesions in the stomach

Dog No	Length of experiment days	Condition of ulcer
1	32	Healed
2	26	Healed
3	25	Unhealed but healing, 1.4 x 1.0 cm.
4	30	Healed
5	30	Unhealed, healing, 1.0 cm. in diameter
6	30	Chronic ulcer, 1.5 cm. in diameter
7	30	Healed
8	30	Healed
9	30	Unhealed but healing, 0.8 cm. in diameter
10	45	Healed
11	45	Unhealed but healing, 0.4 cm. in diameter
12	45	Healed
13	45	Unhealed but healing, 0.4 cm. in diameter

after 45 days Of these 2 ulcers were still present and 2 were healed Had it been practicable to examine these lesions at shorter intervals after operation, a more detailed account might be given of their rate of healing All of the ulcers showed signs of healing except one, which was examined after 30 days and which seemed to have become chronic and

progressive (Fig 24) It had a thickened indurated base and the gastric content at postmortem examination was dark brown and contained blood The remaining ulcers were shallow, not thickened, and a narrow rim of regenerating gastric mucosa could be seen around the border of each Histologically, these healing ulcers did not present any signs of inflammation and the surrounding mucosa appeared normal

e Effect of preventing duodenal regurgitation on the development of ulcers in intestinal transplants in the stomach The experiments of L R Dragstedt and Vaughn (1924), in which transplants of sections of intestine, of spleen, and kidney, into the stomach wall were found to be very little affected by the gastric content, have been referred to above However, in view of the delayed healing of gastric wounds and the increase in gastric acidity when duodenal regurgitation is prevented as described in the preceding section, it seemed desirable to determine whether transplants of intestinal patches into the stomach would survive under the same conditions Morton (1928) has attacked this problem in a slightly different manner but in general our results confirm his findings He transplanted sections of intestine into the stomach of dogs otherwise normal and found that these persisted, the mucosa remaining unchanged When he drained the duodenal juices into the lower ileum as in the Mann-Williamson technique, 3 of the 13 animals developed chronic ulcers in the transplants

In our experiments transplants of intestinal mucosa into large gastric defects were made, as described by the above investigators Great care was observed not to injure the blood supply to the transplant and only catgut was used for suture material Sixteen dogs in all were operated upon, and in 4 transplants were taken from the duodenum, 4 from the jejunum, 4 from the ileum, and 4 from the colon The operations produced little or no subsequent ill effects However, several of the animals developed severe respiratory infections and it is interesting that of these 2 showed evidence of ulceration in the intestinal transplant (one a colon and the other a jejunal patch) when examined a month

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TABLE IV—EFFECT OF PREVENTING REGURGITATION IN TRANSPLANTS

Summary of the data with regard to the incidence of ulcers in intestinal transplants in the gastric wall where duodenal regurgitation has been prevented by a valve in the pylorus

Dog No.	Length of experiment, days	Source of patch	Condition of patch
	45	Duodenum	Two chronic ulcers 1 cm. diameter and 1 cm. o 6
4	30	Duodenum	Two chronic ulcers 1 cm. diameter
1	45	Jejunum	No ulcer
5	30	Jejunum	No ulcer
18	45	Ileum	Large chronic ulcer 3 x 1 cm.
6	30	Ileum	No ulcer
13	45	Colon	No ulcer
7	30	Colon	Two chronic ulcers 2 x 2 cm. and 3 x 4 cm.

later. In all of the others the intestinal transplants were normal, examination being made through a gastrotomy opening at a second operation.

In 8 of the animals, which seemed in the best physical condition a pyloric valve was introduced at the second operation, the remaining 8 being kept for control. They were then returned to their cages and the post operative course carefully observed. It was decided to terminate the experiment about 30 days since in our experience the pyloric valves can only rarely be made to remain in place for a longer period. Half of the animals were sacrificed 30 and half 45 days after the second operation and postmortem examinations were made immediately. With the exception of the 3 animals already noted, of whom had severe respiratory infections, the transplants in the control group persisted and the mucosa remained normal. The data with regard to the transplants in the stomach where duodenal regurgitation was prevented by the pyloric valve are summarized in Table IV. It will be noted that 4 of the 8 developed ulcers in the intestinal transplants and of these 2 occurred in the duodenal mucosa. One of these is illustrated in Figure

SUMMARY

1 Experimental reproduction in the lower animal of a counterpart of the Meckel's diverticulum ulcer of man by the implantation of a small isolated pouch of gastric wall into the jejunum and ileum, yielded chronic progressive ulcers in 85 per cent of trials in the former and in 100 per cent in the latter. This is a striking example of the susceptibility of an organism's living tissues to the irritant action of its own pure, active gastric juice.

2 A chronic progressive ulcer developed in a totally isolated stomach, in the entire absence of food or the motility of digestion, where the important exciting factor was probably the high acid pepsin concentration of the pure gastric secretion.

3 A chronic progressive ulcer developed in the wall of a large Pawlow accessory stomach, which took no part in digestion, whereas the remainder of the stomach, consisting of a small tube made up of the lesser curvature (mesogastrium or gastric canal) and upon which the entire burden of gastric digestion depended remained entirely normal.

4 The development of jejunal ulcers after surgical duodenal drainage as in the experiments of F. C. Mann and his associates is probably not due to mechanical factors or motility since they occurred in 100 per cent of such animals where the muscular pyloric antrum was first resected and a very wide anastomosis made with the jejunum.

5 A repetition of the experiment of gastro-anastomosis made with the jejunum as in the Mann experiment but with implantation of the duodenum 40 centimeters below the anastomosis of the jejunum with the stomach, resulted in the development of only 1 ulcer in 31 experiments. This freedom of ulcer formation was due to the regurgitation of duodenal juices to the region of anastomosis, since the introduction of a valve to prevent such regurgitation led to the formation of chronic progressive jejunal ulcers in 6 cases.

6 Preventing the regurgitation of alkaline duodenal juices into the stomach of normal dogs, by fixing a valve in the pylorus, raised both the free and total acidity of the gastric content after a standard test meal, delayed the neutralization of 0.5 per cent hydrochloric

acid placed in the stomach, delayed the healing of acute ulcers in the gastric mucosa produced by the injection of silver nitrate, and caused the appearance of spontaneous ulcers in transplants of intestinal mucosa sutured into defects in the stomach wall

7 The experimental evidence presented in this paper has been interpreted by the authors to afford substantial support to the view that the chemical action of pepsin hydrochloric acid (of the concentration found in pure gastric juice) can by itself alone produce a typical chronic progressive ulcer in the stomach, duodenum, jejunum, ileum, or colon. The resistance of these organs to the digestive action of pure gastric juice decreases progressively from the stomach to the colon. In the application of these findings to the problem of spontaneous ulcer in man, it should be emphasized that no evidence has been offered which contradicts the possible deterrent action of gastric motility and the mechanical action of coarse food in the healing of acute lesions of the stomach or duodenum. Of these three factors operative in healthy individuals, however, the chemical action of the gastric secretion seems to be the most important both in the production of the acute lesion and in its subsequent chronicity

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HYSTERECTOMY AND THE ARTIFICIAL MENOPAUSE

REVIEW OF LITERATURE, REPORT OF NINETY-ONE CASES

J. VALTON SESSUMS, M.D. GALVESTON, TEXAS, AND DOUGLAS P. MURPHY M.D. F.A.C.S. PHILADELPHIA, PENNSYLVANIA

From the Gynecology Hospital, Institute of Gynecology, Kansas, and the Hospital of the University of Pennsylvania

THE vasomotor disturbances associated with the physiological menopause are currently believed to result chiefly from a derangement of the internal secretory mechanism of the ovary. This belief is based partly on the observation that such symptoms appear when the ovaries are removed prior to the time when the physiological menopause might be expected to take place. Certain clinical observations lead to a further conclusion, namely that the time at which the menopause starts is dependent upon whether the uterus has been removed or not. This belief rests on the observation that menopausal symptoms appear earlier in women whose uteri have been removed than in those who retain this organ, even though in both groups one or both ovaries have been conserved. Whether the inciter of this premature menopause is solely the loss of the ovaries from injury to the blood supply of the ovaries while removing the uterus, or to some other set of circumstances, cannot be stated at present. Observations of many surgeons, however, indicate that the menopause appears prematurely following hysterectomy no matter what its cause may be.

The material which serves as a basis for this conclusion is open to two criticisms. First, many observers have presented too few facts to substantiate their opinions. Second, many of the women operated upon as reported in the literature have been too near the age when the physiological menopause should occur to be as valuable as material from which

to draw such conclusions. In many cases their symptoms were probably physiological in origin rather than pathological.

The present study was undertaken in order to collect evidence regarding the part played by hysterectomy in bringing on an artificial menopause. The literature was searched for reports of patients upon whom a hysterectomy had been performed some years before the physiological menopause would be expected. A follow up study of patients operated upon at the John C. Clark Clinic of the Hospital of the University of Pennsylvania was also carried out.

Physiological menopause. Information was sought concerning the age at which the physiological menopause occurs in women not operated upon. This was done with the idea that the figures obtained would serve as a control to compare with the postoperative findings, and at the same time might influence the selection of the age period for the present study. Sanes, in a study of 476 private patients not operated upon, found the average age at the time of the physiological menopause was 47.1 years. Of this group only 5.2 per cent experienced symptoms before the age of forty years. Norris, from a study of 300 women, found the average age of the menopause to be 48.9 years for married women, 47.7 years for widows, and 46.9 years for spinsters. Of his group only 4 per cent experienced menopausal symptoms below the age of 41. Novak, in a study of 100 women, found that 3 per cent ceased to menstruate before the age of 40. Kish, after a

study of 455 women, found the menopause to occur in 10.5 per cent before the age of 40. The figures enumerated, based on 1,322 women not operated upon (Table I), show that only 5.6 per cent experienced menopausal symptoms before the age of 40. On account of the low incidence of physiological menopause for this period of life, 40 years of age was decided upon as the upper limit for the follow-up period.

CASE REPORTS FROM LITERATURE

In reviewing the literature, only those operative cases were selected in which the hysterectomy was performed before the age of 36 years, and in which at least one ovary was retained that had never been subjected to irradiation. Of some five thousand patients operated upon, and reported in the literature, the records of only 107 (Table I) (reference marked with asterisks) satisfied the requirements for the present study and gave sufficient clinical data to permit their use as the basis for an opinion, concerning the relationship between hysterectomy and the artificial menopause. Of these 107 patients, 53.2 per cent (57 patients) showed menopausal symptoms before the age of 40, whereas less than 6 per cent of women not operated upon suffered before this age (Table I). Of the 57 patients, information was available concerning the time of onset in 41 (Table II). This varied from immediately after operation to 7 years later, the average interval being 15.7 months. Thirty-three (80.0 per cent) of the 41 patients experienced their first symptoms within 2 years of operation, 38 (92.6 per cent) within 3 years.

PERSONAL OBSERVATIONS

Our own observations were made on patients who were operated upon in the John G. Clark Clinic of the Hospital of the University of Pennsylvania. These patients were selected on the following basis: (1) that hysterectomy had been performed before the age of 36, (2) that one or both ovaries had been conserved, (3) that at least one year had intervened between operation and the time of the last report, and (4) that no patient had received pelvic radium or roentgen therapy. These patients were followed either by mail or were

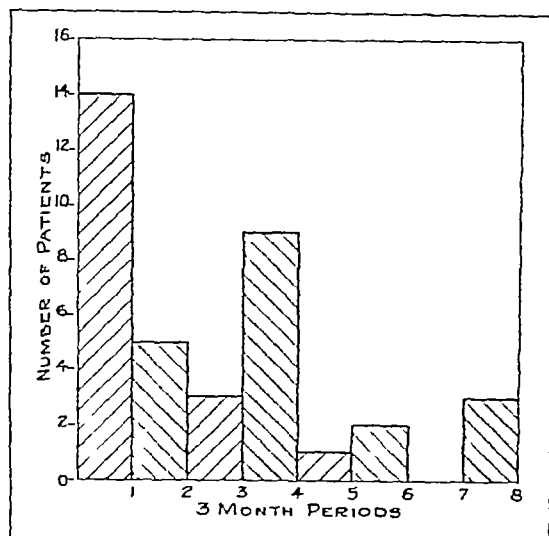


Fig. 1. Showing graphically the time interval between hysterectomy (before 36 years of age) and onset of "hot flashes" in a series of 37 women (Table II) exhibiting their first symptoms within 2 years of operation and before 40 years of age. The base line records time in 3 month periods, the vertical line the number of patients. Note the number of the latter (37.8 per cent) exhibiting first symptoms within 3 months of operation.

seen in the follow-up clinic, in many instances information was obtained from both sources. Information was secured concerning the development of menopausal symptoms and concerning the menses, if they persisted following operation. Knowledge was sought of only one symptom of the menopause, namely "hot flashes." It was believed information pertaining to this one symptom would suffice, and at the same time would be easily obtained.

Information obtained concerning data were secured from 91 patients. Of these, 52 (57.1 per cent) were followed for 5 years or more, 57 (62.6 per cent) for 4 years or more, 69 (75.7 per cent) for 3 years or more, and 82 (90.1 per cent) for 2 years or more. The remaining 9 patients were followed from 1 to 2 years. The ages at the time of operation varied from 20 to 35 years, the average being 30.4 years.

The indications for hysterectomy in this series were equally divided between fibroma uteri and pelvic inflammatory disease.

Eighty-six of the 91 operations were of the supravaginal type, in the remaining 5 cases the entire organ was removed.

TABLE I.—INCIDENCE OF MENOPAUSAL SYMPTOMS UNDER 40 YEARS OF AGE

Condition	Source	Number of patients	Per cent with symptoms
No operation	Literature	322	8.6
Hysterectomy	Literature	107	53.2
	Ours	9	43.9

The incidence of menopausal symptoms in women under 40 years of age, not operated upon, and in those upon whom a hysterectomy with the conservation of one or both ovaries has been performed before the age of 36. Note that symptoms are 8 to 10 times more likely to occur following hysterectomy than when the uterus is not removed.

TABLE II.—TIME OF ONSET OF MENOPAUSAL SYMPTOMS FOLLOWING OPERATION

	Literature	Author's
Number of patients	41	40
Menopausal symptoms, percentage		
Within 3 years	80.0	92.5
Within 3 years	92.6	95
Menopausal symptoms—average time of onset in months	5.7	6

The time of onset of menopausal symptoms before the age of 40 in women subjected to hysterectomy before 36 years of age. Note the large number in whom the symptoms were observed within two years of operation.

*This figure includes 3 patients experiencing first symptoms 1, 2, and 3 years respectively after operation. Omitting these three cases, the average for remaining 37 is 5.2 months.

TABLE III.—RELATION OF MENOPAUSAL SYMPTOMS TO THE AMOUNT OF OVARIAN TISSUE RETAINED

	One	Ovaries retained	Per cent
RETAINED	54	Both	37
Number of patients.			100
Hot flashes	16	8.8	3.4
Present	20	45.9	97.4
Absent.			

The influence of the amount of conserved ovarian tissue upon the incidence of menopausal symptoms, when one or both ovaries were conserved at the time hysterectomy was performed. Note the smaller number of patients having "hot flashes" in the cases where both ovaries were conserved instead of only one.

Of the 91 patients, 40 (43.9 per cent) experienced "hot flashes" before the age of 40 (Table I). Thirty-seven (92.5 per cent) of the 40 patients had their "hot flashes" within 3 years of operation (Figure 1 and Table II) and 31 (77.5 per cent) within the first year. Data concerning the intensity and duration of symptoms were too variable to be of value.

Thirty-one (36 per cent) of the 86 patients on whom a supravaginal hysterectomy was performed menstruated following operation. Twenty were regular; 11 irregular. Only 10 (32 per cent) of these 31 menstruating patients had flashes, whereas 28 (90.9 per cent) of 55 non-menstruating patients had

menopausal symptoms before the age of 40. From this comparison it is evident that the patient is less likely to have "hot flashes" if menstruation persists.

One ovary was removed from each of 54 patients. "Hot flashes" were experienced by 28 (51.8 per cent) of these women before the age of 40 years. In the 37 patients in whom both ovaries were retained "hot flashes" were present in only 12 (32.4 per cent). A comparison of these figures indicates that the artificial menopause is less likely to occur when both ovaries are conserved than when one is removed.

The presence of the menses and the amount of ovarian tissue conserved (one or both ovaries) did not affect the time of onset or the intensity of the menopausal symptoms.

SUMMARY AND CONCLUSIONS

1. A series of 91 women on whom a hysterectomy was performed before the age of 36 years, with the retention of one or both ovaries, has been studied with reference to the incidence of menopausal symptoms occurring before the age of 40.

2. The frequency of these symptoms before the age of 40 was approximately eight times that occurring in a control group of women not operated upon.

3. Ninety-two per cent of the patients exhibiting menopausal symptoms before the age of 40, did so within 3 years of operation.

4. Thirty-six per cent of 86 women on whom a supravaginal hysterectomy was performed, menstruated following operation.

5. Menopausal symptoms appearing before the age of 40 were noted more often in patients without menses than in the ones who retained them, in the ratio of 5 to 3.

6. Menopausal symptoms appearing before the age of 40 were observed more often where one ovary was removed than when both were retained in a ratio of 5 to 3.

7. The time of onset of menopausal symptoms and their severity were approximately the same, whether one ovary was removed or both were left undisturbed.

8. From this study it is concluded that hysterectomy hastens the onset of the menopause.

9 When a hysterectomy is necessary before the menopause, as much endometrium as possible should be retained to favor the continuation of menstruation, and both ovaries should be conserved, if possible

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*Authors reported cases with sufficient data on which to base opinion.

EXPERIMENTAL STUDIES ON SUBARACHNOID ANÆSTHESIA

I PARALYSIS OF VITAL MEDULLARY CENTERS

FRANK WANG COTUI M.D. AND SAMUEL STANDARD M.D. NEW YORK

Respectively from the Laboratory of Surgical Research, New York University and Bellevue Medical College, and from the New York University
Surgical Division of Bellevue Hospital, and the Department of Physiology New York University and Bellevue Hospital Medical College

IN spite of the really voluminous literature that has accumulated on the subject of subarachnoid anesthesia, there still seem to be important questions on which authorities differ radically. This is so perhaps, because most of the publications were written from the clinical standpoint or were reports of experiments performed with immediate clinical ends in view. The clinical phases of the subject, such as the preparation of the patient, the technique of injection the advantages and disadvantages to the surgeon of this type of anesthesia, have been the subject of exhaustive treatment. But the basic principles involved have not been sufficiently subjected to critical study. Such factors, for instance, as the possibility of paralysis of the medullary centers, the incidence of intercostal paralysis, the range and effects of the fall in blood pressure, and finally the etiology of complications and the measures indicated for combating them—for a knowledge of these fundamental questions, we have been dependent upon the opinions of authorities whose statements are too often based on clinical impressions rather than scientific investigation.

The effects of cocaine or its derivatives on the vital bulbar centers, i.e. the respiratory and vasomotor centers, seem to us to be the most important question involved.

Clinical authorities are divided into two camps on the subject of the paralysis of the vital medullary center. Dr. Labat, who is in charge of the section of Regional Anesthesia of the Department of Surgery New York University and Bellevue Hospital Medical College, states respiratory failure and all other symptoms associated with spinal anesthesia are not due to the diffusion of the injected fluid to the brain and to the deleterious effects of the drug on the respiratory center but rather to cerebral anemia caused by the fall in blood pressure. In this he is seconded by Evans who

states the respiratory depression is from bulbar anemia, consequent upon the fall of blood pressure." Bryant states "that when death, due strictly to the anesthesia method occurs in spinal anesthesia cases, it is not due to toxic effect of an average dose of the anesthetic drug nor is it due to paralysis by high diffusion of the latter a common and erroneous belief. Death in such cases is due to cerebral anemia. Babcock doubts the existence of medullary paralysis from the proper use of spinal anesthesia. Koster and Kasman by application of a pledget of cotton soaked in neocaine solution to the exposed closed portion of the medulla of frogs, guinea pigs, and cats, found that although the animals became anesthetized, there was no effect on the respiration, and they concluded, therefore, that even in large concentrations procaine does not paralyze the respiratory centers.

On the other hand Pauchet refers to "asphyxia by bulbar inhibition due to ascension of the drug to the medulla and mentions having had three such cases in which artificial respiration was necessary. Pitkin believes that it has been shown that the injection of tropicaine, novocaine and stovaine into the spinal cord will cause immediate death with typical medullary symptoms. Sise attributed the fatality in 4 of 11 fatal cases he analyzed to "a dose of anesthetic which rose in the spine and became placed very high, probably in the medulla." Rygh and Bensen believed that the cause of 1 of their 3 deaths was the action of the drug on the respiratory center by its access to the fourth ventricle. Boyd and Yount attributed 2 of their 4 deaths to spread of the drug to the medulla. Morrison speaks of "toxic impairment of the medullary center." And Allen states that the immediate danger following spinal anesthesia may occur as a result of paralysis of the respiratory bulbar vasomotor and other higher centers."

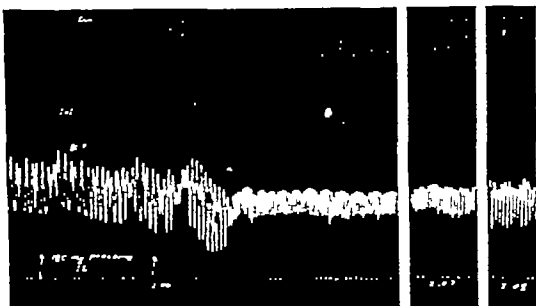


Fig 1 Spinal injection. Dog 6—17.5 kilograms *Dia*, Diaphragmatic breathing, *Int*, costal respiration, *Bl P*, blood pressure. At *A*, 15 seconds after injection, blood pressure fell slightly, the change in pulse pressure being more marked. At *B*, 30 seconds after the injection, the costal respiration starts to decrease in amplitude.

2.07 strip costal respiration is almost completely paralyzed.

2.08 strip costal respiration is completely paralyzed. Diaphragmatic contractions, however, keep on going. Both the systolic and pulse pressures are recovering.

Experimentally, most workers in this field agree that a paralysis of the medullary centers occurs when a large enough dose of cocaine derivative is made to reach the medulla. Aducco showed that the applications of crystals or of a salve of cocaine on the floor of the fourth ventricle of a dog led to respiratory paralysis. Jonnesco and Jiano obtained respiratory paralysis by injection of stovaine into the mid-cervical subarachnoid space and thought the paralysis to be central in origin. Bellelli also could get respiratory paralysis by injecting novocain through the atlanto-occipital membrane, and Janossy studying the action of coramine on the respiratory center, used the paralyzing effect of tropacocaine injected cisternally as a basis of experimentation. And recently Vehr, injecting procaine into the cisterna magna, came to the conclusion that only very large doses can cause respiratory paralysis. Jonnesco and Jiano, Bellelli, Janossy, and Vehr, since they show no tracings, leave uncertain the question whether the paralysis of the respiratory mechanism was central.

The most convincing work was done by Bloch, Camus and Hertz, in 1921, who demonstrated that stovaine and syncaïne injected through the atlanto-occipital membrane of a dog caused a sequence of symptoms terminating in paralysis of the respiratory center, that by artificial respiration the animal could be

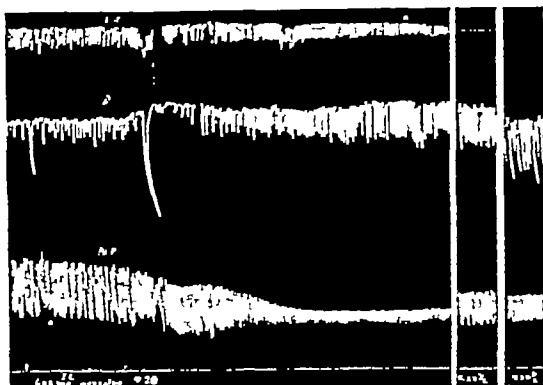


Fig 2 Spinal injection. Dog 9—18 kilograms *Int*, Costal respiration, *D*, diaphragmatic respiration, *Bl P*, blood pressure. The blood pressure starts to fall before injection is complete. The fall in both systolic pressure and pulse pressure is more marked than in Figure 1. At *A*, the costal respiration starts to decrease in amplitude.

4.22½ strip the costal respiration is almost paralyzed, the diaphragmatic respiration has increased in amplitude, the blood pressure is recovering in both systolic and pulse pressure.

4.26½ strip the costal respiration is paralyzed and the diaphragmatic has increased further in amplitude.

made to live, and that caffeine injected intracisternally was of decided benefit. Camus, in 1922, with tracings, showed the same phenom-

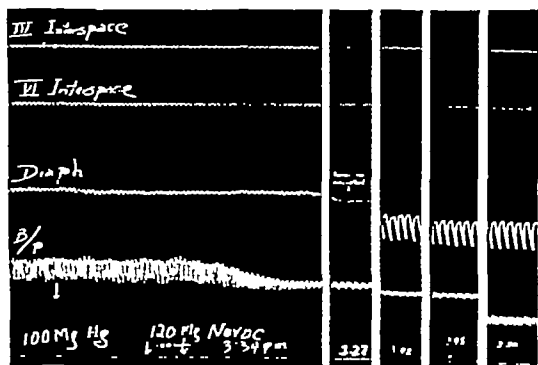


Fig 3 Spinal injection. Dog 11—weight 20 kilograms *III*, Costal respiration registered from third interspace, *VI*, same from sixth interspace, *Diaph*, diaphragmatic respiration, *B/p*, blood pressure.

3.37 strip the breathing from the sixth interspace is decreasing in amplitude, that from the *III* space is normal except for decreased rate. The diaphragmatic tracing is an artifact due to too tight a lever.

3.42 strip *VI* is paralyzed, *III* is decreasing in amplitude, the apparent increase in diaphragmatic tracing is due to readjustment of the lever.

3.48 strip *III* is paralyzed, *VI* registers negative waves due to sinking in of thorax during inspiration.

3.54 strip both *III* and *VI* register negative waves. The diaphragmatic excursions show increased amplitude.

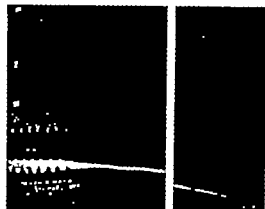


Fig. 4. Cisternal injection. Dog 7—17 kilograms. III, Respiration registered from third interspace. V, same from fifth interspace. VII, same from seventh interspace. D, diaphragmatic respiration. P, blood pressure. In 10 seconds after injection, III, V, VII, and D are alternately paralyzed. The blood pressure gradually falls, reading 0 at 507.5 minutes after injection.

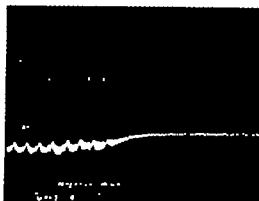


Fig. 5. Cisternal injection. Dog 4—15 kilograms. C, costal respiration. D, diaphragmatic; P, blood pressure. Note the prolonged rise of blood pressure indicating the slight period of respiratory depression.

enon with novocain, and Soupalt, in 1913, could identify the same sequence of events in a patient who had 10 centigrams novocain injected into the spinal canal between the first and second lumbar interspaces. The work of the four mentioned authors has not had the recognition it merits.

In view of the divergence of opinion as detailed, it seems desirable to submit the subject to a reinvestigation. The following study was undertaken with the object of determining (1) the effects of procaine upon the respiratory and vasomotor centers and (2) the efficacy of measures of resuscitation.

The work will be presented in the following order:

I. Injection of procaine into the spinal canal the subject of a separate study is introduced here as controls, to make clear our methods, reasoning and conclusions.

II. Injection of procaine into the cisterna magna as the best method of getting the drug in contact with the medullary centers in the intact animal.

III. Localization of the action of procaine injected cisternally.

IV. Resuscitation measures.

V. Difference in lethal dosages in normal and anesthetized animals.

Dogs were used in these experiments. Each was given morphine hydrochloride 5 milligrams per kilogram subcutaneously and sodium amytal 25 milligrams per kilogram intravenously.

A pneumograph applied around the chest and connected to a tambour recorded the costal breathing, while a string attached to the anterior abdominal wall and made to pull on a lever recorded the diaphragmatic breathing. A brief explanation of the mechanism of these two systems of registration may be pertinent. During inspiration the chest expands, and the abdomen bulges. The expansion of the chest stretches the pneumograph and produces a partial vacuum in the closed system. The membrane of the tambour therefore falls and the lever falls with it. The bulging of the abdomen slackens the string attached to it, allowing the lever to fall of its own weight. During inspiration, therefore both the costal and diaphragmatic levers fall while during expiration they both rise. The blood pressure was recorded by connecting a registering mercury manometer with the femoral artery.

Spinal injections. When procaine is injected into the subarachnoid space at the first lumbar space in dosages of 100 to 600 milligrams the following events take place (Figs. 1 and 2). There is at first a fall in blood pressure and a fall in pulse pressure. The respiration both costal and diaphragmatic, is at first quickened in response to the fall in blood pressure then

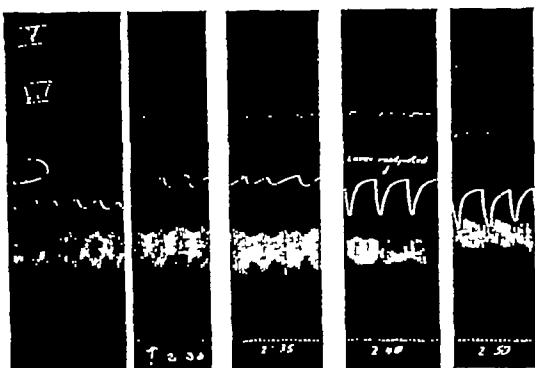


Fig 6A. Localization experiment. Dog 13, weight 15 kilograms. Upper cervical laminectomy exposing closed portion of medulla and upper cervical cord. IV, Costal respiration registered from fourth interspace, VII, same from seventh interspace, D, diaphragmatic respiration. Cotton pledget soaked in $2\frac{1}{2}$ per cent procaine solution applied to exposed closed portion of medulla at time marked by arrow in strip 2:30. The apparent increase of diaphragmatic excursions is due to readjustment of lever previous to the taking of the tracing. No intercostal or diaphragmatic paralysis occurred in the period from 2:30 to 2:50.

the rate is slowed, then dissociation occurs in that the amplitude of the costal breathing is gradually reduced, until at the end of some 3 to 18 minutes, depending upon the dose, the bulk of injected fluid and the speed of injection, it is entirely stopped. The diaphragmatic contractions on the other hand are not affected at this time and in fact, in Figures 2 and 3, they seem to compensate for the intercostal paralysis by increased amplitude. By the application of two or even three pneumographs at different levels of the chest above the eighth rib, it can be shown that this costal paralysis is ascending, that is, the intercostal nerves are paralyzed one after another as the drug diffuses upward (Fig 3).¹ This intercostal paralysis is interpreted as peripheral, that is, paralysis of the nerve roots as they emerge from the cord.

Injection into the cisterna magna. When procaine is injected into the cisterna magna, however, an entirely different picture is presented (Fig 4). As small a dose as 60 to 70 milligrams in a 17 to 20 kilogram dog produces a

¹ Pneumographs applied to the chest at a lower level than the eighth rib will not show purely costal breathing, especially when the drum is run at a slow speed and the tracings are too close together for analysis. The diaphragmatic digitations inserted from the eighth rib downward cause the ribs to move even if the intercostals are paralyzed.

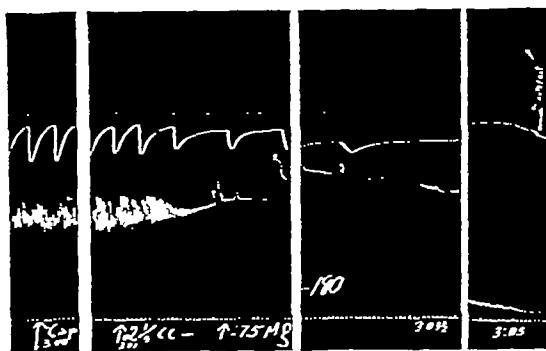


Fig 6B. Continuation of localization experiment. No respiratory paralysis even at 3:00, 30 minutes after application of the drug. Capillary pipette introduced into fourth ventricle at time marked by first arrow.

3:01 strip first part shows no apparent change in respiration or blood pressure caused by introduction of the pipette. Between second and third arrows in strip 3:01, $2\frac{1}{2}$ cubic centimeters of the same solution was run through the pipette into the fourth ventricle. Note immediate decrease in respiratory rate and amplitude, and rise in blood pressure. The irregular line on the blood pressure curve is due to improperly writing blood pressure lever.

3:03½ strip blood pressure is 180 millimeters, the respiration is paralyzed.

3:05 strip the costal and diaphragmatic respirations both are paralyzed, the hump on the diaphragmatic curve is due to loss of tone of the diaphragm. Blood pressure has fallen to 0. The irregularities at the end of the respiration tracings are due to mechanical causes.

swift simultaneous stoppage of both intercostal and diaphragmatic respiration, and a fall in blood pressure without any preliminary rise in response to asphyxia, as would be expected from a normal vasomotor mechanism. Sometimes, however, when the dose injected is small, the blood pressure registers a rise (Fig 5). The effects on the vasomotor mechanism will be taken up later.

The small size of the dose injected and the simultaneous cessation of the whole respiratory mechanism and fall in blood pressure, suggest an effect on the respiratory and vasomotor centers themselves. The fact that the cisterna magna communicates by the foramina of Luschka and Magendie with the fourth ventricle, on the floor of which are located the centers, makes the probability of a direct effect very strong.

Two other possibilities, however, must be considered. First, a paralysis of the phrenic and intercostal roots by a diffusion of the drug from the cisterna downward. Offhand, if this

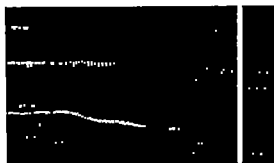


Fig. 7A. Resuscitation experiment. Dog's weight 20 kilograms. Caudal injection. *T* Costal respiration, *D* diaphragmatic. *BP* blood pressure. Note the respiratory paralysis 40 seconds after injection. Artificial respiration started at 4:46 marked by third arrow. The irregularities in *A* on the blood pressure curve are due to poorly writing lever.



Fig. 7B. Resuscitation experiment continued. At 5:05, marked by the two arrows, 30 milligrams epinephrine hydrochloride is given intravenously. Note latent time in rise of blood pressure.

53.4 strip blood pressure has risen to 30 millimeters.

were true, we would expect from analogy with our spinal experiments a paralysis of the diaphragm to take place first followed by that of the intercostals in a descending order. This, however, did not occur. The second possibility is the permeation of the drug into the cord substance in sufficient quantity to paralyze the neurones, arising from the respiratory center and running in the cord down to the anterior horn cells of the phrenic and intercostal nerves. The localization experiment described below excludes the last two explanations.

Localization of action. An upper cervical laminectomy was done the atlas, the second cervical vertebra, and a part of the basilar portion of the occipital bone being removed. This operation opened the cisterna, thus exposing the inferior aspect of the cerebellum, the closed portion of the medulla, and the upper cervical cord. A pledget of cotton soaked in 2½ per cent solution of procaine in cerebrospinal fluid carrying about 5 cubic centimeters representing 150 milligrams of the drug was placed over the closed portion of the medulla and the upper cervical cord. The head of the dog was then tilted slightly upward to allow gravitation of the excess fluid downward. Tracings taken in the course of 30 minutes showed neither respiratory paralysis nor appreciable changes in the blood pressure (Fig. 6). This shows that whatever diffusion downward or whatever permeation of the drug into the cord had occurred this was

not sufficient to paralyze either the phrenic and intercostal roots or the neurones going out of the center. Koster and Kaaman in a similar experiment on a cat and guinea pig obtained results differing from those here reported. The difference in the technique employed may serve to explain our diametrically opposite results.

A curved, blunt, capillary pipette was slowly introduced through the posterior medullary velum into the fourth ventricle, care being taken not to injure the floor of the fourth ventricle by keeping close to the vermis of the cerebellum. Tracings taken for about a minute after the introduction of the pipette showed that no change due to the mechanical introduction had occurred either in the respiratory or blood pressure curves (Fig. 6A). Then 2.5 cubic centimeters of the solution containing 75 milligrams of procaine was allowed to flow by gravity through the pipette into the fourth ventricle. In less than 30 seconds the costal breathing stopped, followed soon after by paralysis of the diaphragm (Fig. 6B). The blood pressure registered a rise, then fell to zero and the dog died.

Our explanation for the occurrence of paralysis when injection was made into the cisterna and for the non-occurrence of paralysis when application was made to the closed portion of the medulla, is that in the first case, in the closed system of an intact cisterna magna, diffusion could occur from the cisterna through the foramina to the fourth ventricle while in the second case, the fluid having been spilled, no vehicle for diffusion was present. To verify

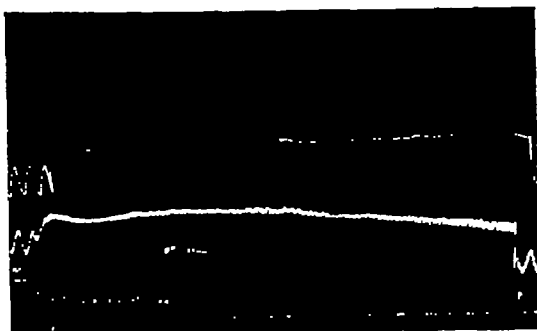


Fig 7C Resuscitation experiment continued At 5 30 (point of arrow), artificial respiration discontinued Note rise in blood pressure in response to asphyxia, showing recovery of vasomotor center Note continued paralysis of respiration Artificial respiration started again at time marked by second arrow

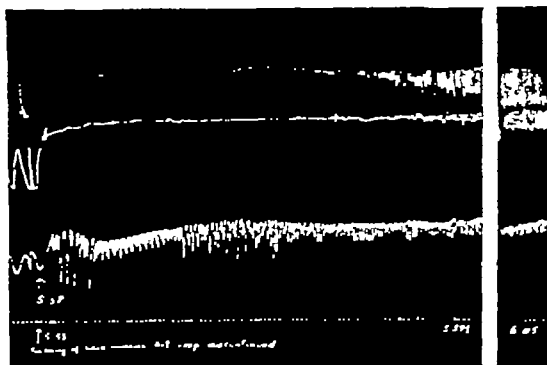


Fig 7D Resuscitation experiment continued Twitching of neck muscles seen at 5 58—so artificial respiration is discontinued Note the recovery of spontaneous respiration

the correctness of this explanation, methylene blue was injected into the cisterna magna of an intact dog in one case and applied to the closed portion of the medulla exposed by an upper cervical laminectomy similar to the one described above in another case On examination of the brains at the close of the experiment, it was found that in the case of injection into the cisterna the fourth ventricle was colored blue, whereas in the animal in which the methylene blue was applied to the exposed medulla and upper cervical cord, the floor of the fourth ventricle showed no traces of methylene blue

In the case of blood pressure, whether a rise or fall is registered depends upon the dose In Figures 4 and 7A, there was a fall from the beginning of the experiment, in spite of the asphyxia occasioned by the respiratory cessation This would indicate a primary paralysis of the vasomotor centers In the experiments with smaller dosage (Figs 5 and 6B), there may be at first a rise in blood pressure, then a gradual fall to zero in spite of the institution of artificial respiration or a primary rise without any subsequent fall Whether this rise is due to the asphyxia, to stimulation of the vasomotor center, or to a combination of both factors or to other factors, yet unknown, we are unprepared to say The fact that paralysis of the respiratory centers occurs first would suggest either that the vasomotor center is not anatomically as exposed to the procaine or that it is more resistant The finding of Tatum and his co-workers that in poisoning

by cocaine systematically administered, the respiration stops before the heart, is interesting in this connection

Resuscitation experiment With this evidence pointing to respiratory and vasomotor paralysis due to the injection of suitable doses of procaine into the fourth ventricle or into the intact cisterna magna, the subsequent procedures were carried out in an attempt to evaluate the efficacy of certain resuscitative measures A 20 kilogram dog was given 60 milligrams of procaine hydrochloride at 4 45 marked on the tracing by the two arrows in Figure 7A As will be seen from the graph, there was respiratory paralysis and a steady decline of the blood pressure, no asphyxial rise being in evidence Artificial respiration was started 30 seconds after respiratory stoppage, but the blood pressure continued to fall to about 5 millimeters At 5 08 (Fig 7B), 23 minutes after the injection, 30 milligrams of ephedrine sulphate was injected into the femoral vein, after a latent time of 38 seconds, the blood pressure started to rise until at 5 14 it was above normal At 5 33 (Fig 7C) the artificial respiration was discontinued to determine if the respiratory center had recovered Such interruptions of the artificial respiration were repeated at 5 43 and 5 53, but recovery had not yet taken place At 5 58 (Fig 7D), 1 hour and 13 minutes after the injection, twitches of the neck muscles were seen These twitches were interpreted as the beginning of return of spontaneous activity of the respiratory

TABLE I.—NORMAL DOGS

Weight (kg.)	Fatal dose procaine (mg.) Intracranially
11	104
8 1/2	90
3	90
14	15
11 1/2	103
10	90
7 1/2	90
8	95
5	90

*From 1 cbr. series

TABLE II.—FATAL DOSES

MORPHINE-SODIUM AMYTAL DOSE

Weight (kg.)	Fatal dose procaine (mg.) Intracranially
7 1/2	50
30	60
7	70
8	70
15	60
19	65
3	30

SODIUM AMYTAL†

15 1/2 (40 mg. sodium amytal per kilo)	15
1 1/2 (45 mg. sodium amytal per kilo)	75

*Morphine hydrochloride 1 milligram per kilogram was given intracranially and sodium amytal 15 milligram per kilogram intracranially before the experiment.
 †Given intracranially.

center. The artificial respiration was discontinued and in little over a minute, both the intercostal and diaphragmatic breathing recovered spontaneously. At the end of the experiment therefore the dog was, to judge from the respiratory and blood pressure tracings, as well as it was when the experiment started.

Differences in the fatal intracranial dose in anesthetized and unanesthetized dogs. Normal dogs require a much larger dose of procaine intracranially to kill than dogs anesthetized with morphine and sodium amytal or with sodium amytal alone. The two tables, one representing comparatively large doses that failed to kill normal dogs (Table I) and the other representing fatal doses in dogs anesthetized with morphine and sodium amytal or with sodium amytal alone (Table II) will show the difference. Some of the experiments in Table I are from 1 cbr.'s series. This finding, that a barbituric acid derivative reduces the lethal dose intracranially of procaine hydrochloride, is apparently at variance with the

work of Hofvendahl, Tatum et al, La Mendola, and Martin who showed that members of the barbituric acid series raise the minimum lethal dose of cocaine administered subcutaneously. The discrepancy however is more apparent than real. In cocaine poisoning brought about by the systemic administration of cocaine, the convulsive phase is the striking feature, whereas in injection into the cisterna magna, the paralytic phase is predominant. The works of Jacoby and Roemer Impens, Jackson, and Bouckaert showing that the barbitals in large doses have a depressing effect on respiration, explain the increased vulnerability to procaine of animals narcotized with sodium amytal.

This lowering of the lethal dose of procaine injected intracranially by the previous administration of barbituric acid derivatives is significant in view of the increasing tendency to use them as a "basal anesthetic" in cases of spinal anesthesia. According to our findings, it is distinctly contra-indicated and is a misapplication of the findings of Hofvendahl, Tatum, and others.

The work now in progress is an investigation of the effect of certain pathological conditions and of drugs other than sodium amytal on the resistance of the medullary centers to the paralyzing effect of procaine.

SUMMARY

1. Procaine through direct action on the medulla produces respiratory and vasomotor paralysis when injected in sufficient concentration into the cisterna magna.

2. When complete paralysis occurs, artificial respiration and the intravenous injection of ephedrine are effective as measures of resuscitation.

3. In sodium amytal and in combination morphine-sodium amytal narcosis, there is a lowered resistance of the centers to the paralyzing effects of procaine.

This study was made at the suggestion of Professor George David Stewart of the department of surgery and of Dr. Arthur M. Wright, director of the New York University Surgical Division of Bellevue Hospital, to both of whom we wish to acknowledge our thanks for their constant interest and encouragement throughout the course of this work. We also take pleasure in thanking Professor George B. Wallace of the department of pharmacology for his helpful suggestions and criticism.

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THE MECHANICS OF THE REVERSE FLOW OF BLOOD IN VARICOSE VEINS AS PROVED BY BLOOD PRESSURE READINGS

ITS CLINICAL APPLICATION TO THE INJECTION TREATMENT

H. O. McPHEETERS, M.D. F.A.C.S. C. E. MERKERT, M.D. AND ROY A. LUNDBLAD, M.D. MINNEAPOLIS, MINNESOTA

MUCH has been written on the direction of the venous flow in varicose veins. Even so the subject is not settled in the minds of many men for sufficient proof has not been forthcoming to prove conclusively the true pathological situation existing.

THE NORMAL FLOW

The venous blood of the lower extremities is normally returned to the heart by means of the superficial and deep systems of veins. The superficial system is the one in which we are primarily interested at this time as in the great majority of cases the veins of the deep system with their valves remain normal and intact.

The superficial and deep systems of veins are connected by means of communicating veins. A large number of these are scattered throughout the lower leg and about the knee while in the lower thigh only a few are present and in the upper thigh often none exists. These communicating veins are also provided with valves which normally prevent the reverse flow of blood from the deep system outward.

From the time that varicose veins were recognized as pathological entities it has been the assumption that the upward flow of blood in them is markedly slowed and that varices remain as large, dilated tubes of blood.

A milestone was set in 1891 by Trendelenburg when he presented his classical thesis and paper in which he so clearly discussed the pathology of varicose veins that his conclusions are still accepted as accurate. The position in which the patient is placed while being studied still bears his name. Trendelenburg evolved certain tests that very clearly proved to him that the blood flowed downward from the saphenofemoral opening in certain cases and outward through the communicating veins in others.

Many authorities, Delbet and Mocquot, Hasebroeck and others, stated that in their opinion the deficiency of the valve at the saphenofemoral opening is the first step in the formation of varicose veins. This deficiency may be due to a degeneration of the valves with approaching age. In other cases there is no question but that it is due to a gradual widening of the vein lumen by a simple stretching of the vein walls which pulls the edges of the valves apart, thus allowing a true mechanical incompetency to develop though the valves themselves are not injured. In either of these events the blood would no longer be held in the vein above the valves but would flow in either direction according to the point of greatest hydraulic pressure.

These findings are clearly shown and proved by the simple application of the Trendelenburg test. When this test is made, the patient lies down with the foot and leg elevated high. The force of gravity would thus empty the varices and draw the blood into the general venous system. A tourniquet is tightly applied about the upper or middle thigh and the patient is allowed to stand. In any well developed case of varicose veins those veins above the tourniquet will rapidly fill but those varices below it will remain collapsed. If when the tourniquet is suddenly removed the lower varices fill rapidly the conclusion is drawn that they have filled with blood from above. This state of affairs is termed a Trendelenburg positive. When the test is made with the tourniquet tightly applied and the patient standing if the varices fill quickly from below then it is clear that the varices have filled from the deep system due to incompetent valves in the communicating veins. This condition is called a Trendelenburg negative. In some cases the varices will fill rapidly from below but when the tourniquet is removed they will fill still more tensely and then we have what is termed

a Trendelenburg double. By this we mean that the blood has come both outward through the communicating veins and downward through the great saphenous from the deficient valves above. Occasionally, the veins of the lower thigh and lower leg have become dilated and distended, yet all the valves are competent. In this case the varices would simply fill slowly with the returning blood from the distal parts of the extremity. Such a condition is called a Trendelenburg nil.

This pathological flow was very clearly demonstrated on several different occasions under the fluoroscope by means of lipiodol injections. It was also proved by Jentzer and other men abroad. A repetition of the experiment seemed to give more positive data than had been obtained before.

A patient with Trendelenburg positive varicose veins size 4 (2 centimeters in diameter), from groin to calf, was placed in the prone position on a tilting X-ray table. The leg was raised high to empty the varices. A tourniquet was then applied about the upper thigh just below a high varix. The table was then tilted bringing the patient erect. The large varix above the tourniquet rapidly filled while those below remained empty. Two cubic centimeters of lipiodol was injected into the distended loop above the tourniquet as shown in Figure 1. The tourniquet was then removed and the varicose system below filled with a gush carrying the lipiodol with it as shown in Figure 2. The lipiodol remained in position as in Figure 2 until the patient stepped back and forth, first on one foot and then on the other, thus contracting the calf muscles similar to that which would occur in walking. As this was done, the lipiodol rapidly disappeared into the deep system. This disappearance is explained as follows:

When the patient is standing still there is a constant upward surge of blood from the distal part of the extremity due to the *vis a tergo* being carried through the capillaries, the mild aspiratory effect of inspiration, and the increase of pressure on the deep veins by the contraction of the calf muscles which completely surrounds them.

In this discussion we will liken the muscles of the lower leg to those of the heart. The



Fig 1, left. Two cubic centimeters of lipiodol had been injected into a large distended varix, size 4, in the midthigh just above a tourniquet. The varices of the entire leg had been emptied previously by having the patient lie down with the foot in high elevation. The tourniquet was then applied in this position. Those varices above the tourniquet rapidly filled as soon as the patient stood up.

Fig 2. The tourniquet has been removed allowing the lipiodol, as shown in Figure 1, to be carried downward with the blood in the distended varices above into the collapsed and comparatively empty varicose segments of the lower leg. Note that some of the lipiodol has gone as low as the internal malleolus.

resultant action of the contraction of muscle groups in the leg is the same as in the heart, that is, to compress the contents and cause its expulsion through the patent openings into blood channels. In the heart these are the pulmonary artery and the aorta. In the calf they are the deep veins which pass upward and unite to form the deep femoral. During the period of relaxation, the deep veins of the lower leg are nearly empty and waiting to be filled the same as the chambers of the heart during the period of relaxation. For this reason it is very logical that we speak of the systolic and diastolic phase of muscular action of the lower leg inasmuch as it so accurately explains the normal functioning of the part and its action on the contents of the deep veins.

Let us accept this hypothesis as a basis for our reasoning. With the patient standing still, with all muscles tonic, the venous flow is upward similar to the overflow of a spring. Just as soon as this patient begins to walk the systolic contraction of the muscles of the lower leg empties the deep veins of the calf

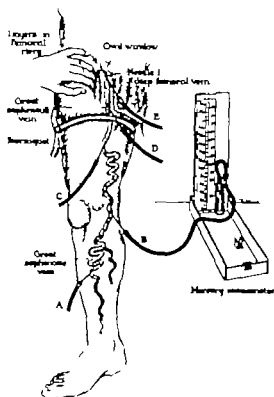


Fig. 3. Drawing showing the technical details of the experimental work on the blood pressure in varicose veins.

The competent valves of the deep veins maintain the column of blood above them, so that at the beginning of the diastolic period of the muscular action of the calf muscles the deep veins are empty as fluids tend to flow in the direction of the lesser pressure. At the beginning of the diastolic phase of the calf muscular action the superficial varicose veins are filled and distended. The pressure in the varices of the calf at that time may be as high as 88 millimeters of mercury due to the weight of the column of blood in the distended vein up to the saphenofemoral opening and up to the heart. It is clear then to expect that the blood would flow through the communicating veins to fill the deep veins to a pressure equal to that in the superficial varicose veins. Temporarily the pressure in the superficial veins would drop slightly during this diastolic phase only to rise again due to the reverse flow of

TABLE I.—THE BLOOD PRESSURE READINGS AS RECORDED IN AUTHOR'S CASES

From	E	I	A	B	A
Standing—sphygmograph on	7				7
flexing—sphygmograph off	36				36.7
Five seconds	38.8			75	42.7
Ten seconds	33.2		48	43.6	37.3
Fifty seconds	33.6		40	46.6	37.1
Twenty seconds	33.6		40	46.6	37.1
Gravating	46		41	34	50
Walking	49		36	36	54
Supination	43		34		
Supination	44		34		

E, Deep femoral just above saphenofemoral junction. D, great saphenous vein. C, saphenous in upper thigh. B, internal case, A, and calf. Practically the same through as at I.

blood from above when the deep veins are filled, that is during the systolic phase of the calf muscles.

This condition is most clearly seen and observed in a case with a marked *positive* Trendelenburg but with no *negative* Trendelenburg because the valves in the communicating veins would still be functioning and prevent an outward flow of blood from the deep system under the pressure of the systolic contraction of the calf muscles. If there were a marked *negative* Trendelenburg present then the valves in the communicating veins would be so deficient that they would not prevent this outward flow during the systolic period. On the contrary the high venous pressure in the superficial varicose veins of the lower leg would be maintained due both to the reverse flow from the great saphenous above and the outward flow from the deep veins of the calf through the incompetent communicating veins. Due to this continuous stagnation and the high venous pressure the blood serum is forced outward through the walls of the veins and into the capillary spaces of the tissues and thus develops the state of edema of the tissues. In this way we would have developed the state of supersaturation of the tissues of the lower leg. This occurs most about the lower third and ankle. Secondary to this poor and deficient circulation the trophic state of the tissues becomes lowered and we have the *locus minoris resistentie* developed for a varicose ulcer to form following a slight injury or a hematogenous infection.

PROOF BY MEANS OF BLOOD PRESSURE READING

We undertook to prove the soundness of the theory described by means of simula



Fig 4

Fig 5

Fig 6

Fig 7

Fig 8

Fig 9

Figs 4 and 5 The skiodan was injected into the varicose saphenous in lower thigh as described. It was carried downward into the varices of the lower leg. It then passed through communicating branches into the deep system where it was collected again into the popliteal vein and is shown passing upward to the femoral.

Fig 6 This shows the skiodan mixed with equal parts of the usual salt and sugar mixture used in the injection treatment of varicose veins. This solution was injected into the varices of the calf and lower thigh exactly as is done when treating a case of varicose veins as described herein. The area of constriction is still shown below the knee where the tourniquet was applied in the effort to retain the solution locally. Another tourniquet was applied in the lower leg and a third in the lower thigh. The latter barely shows in the picture.

Fig 7 The tourniquet has been removed and the patient has been stepping back and forth from one foot to the other, thus expelling the blood from the deep system. It will be noted that most of the skiodan has been drawn downward from the great saphenous and that in the calf it is much more diffuse and diluted. Further stepping washed the veins empty of the skiodan.

Fig 8 Another case of varicose veins of the lower leg injected with the mixture of skiodan and sugar solution equal parts. Tourniquets are shown below the knee and at the ankle. They clearly demonstrate how the injected solution can be retained locally.

Fig 9 The solution is entirely disappearing following removal of the tourniquets and having the patient step back and forth from one foot to the other.

neous blood pressure readings at different points along the course of the varices of the great saphenous system (Fig 3). We believed that the increase or decrease of blood pressure occasioned by the change of posture, prone or standing, would give us accurate data as to the direction of the venous flow inasmuch as the blood would flow strictly according to the rules of hydraulic pressure and fluids would tend to seek their level. This pressure would be due to the combined effect of gravity plus muscular action. The pressure in the superficial veins was also checked against that in the deep femoral just below Poupart's ligament (Table I).

The readings were taken at point A or mid calf, B internal knee, C, saphenous in upper thigh, and E in the deep femoral just above saphenofemoral junction.

I will not bother you with tedious details of laboratory methods used but suffice it to say that from the readings shown in Table I it is very clearly seen how the pressure in the great saphenous at D quite constantly approximated the pressure in the deep femoral which would mean that the valve controlling the reflux flow at the saphenofemoral opening was deficient and the flow of blood was in either direction, outward from the deep femoral or inward from the great saphenous ac-

according to the direction of the greatest pressure either due to gravity or to muscular activity. The systolic effect of the calf muscles was beautifully demonstrated showing how the contractile force of these muscles during walking would force the blood upward through the great saphenous. This point is of great importance and interest in the study of the supportive rubber sponge and Ace bandage treatment of varicose ulcers. With the patient standing the intra-abdominal pressure raised the pressure at all points quite considerably meaning that the back pressure on all the vein valves was markedly increased. When the table was tilted and the patient brought to the prone position the pressure rapidly dropped and when the leg was elevated the pressures were almost zero. This latter reading bears out clearly the effect of gravity in aiding the circulation and clearing away the edema of the lower leg in cases of phlebitis and of ulcerations when the patient is put to bed with the leg in high elevation and hot packs.

To demonstrate visually the soundness of the conclusions drawn from the blood pressure tests 20 cubic centimeters of a 40 per cent solution of skiodan was injected into the great saphenous vein at point C with the patient standing erect and the varicose system previously emptied as described (Figs. 4 and 5). Twenty cubic centimeters more of the solution was injected rapidly as the tourniquet was removed. The skiodan solution was carried downward and spread through the venous tree of the varicose system exactly similar to its spread through the arterial system when injected there.

In the injection treatment of varicose veins it is essential to obtain the best results, that we at all times keep in mind this reverse flow. It is our aim to bring the sclerosing solution into direct contact with the intima of the vein. This should at all times be controlled

as much as possible as to the strength and concentration of the solution its dilution by the blood and its localization in the areas and segments of the veins, being treated. This can be accomplished by using the force of gravity to empty or fill the varices as desired combined with the use of tourniquets or occluders to retain and localize the injected solution. (Figs. 6, 7, 8 and 9.) The posture of the patient varies for the individual case although most patients are injected lying prone. At times the reverse flow is so marked that the injections are actually started with the leg in elevation while later it is lowered below the level of the table.

SUMMARY AND CONCLUSION

A. In any well developed case of varicose veins the blood is slowed or stagnant. When a patient is walking the flow is actually reversed and is outward from the femoral and downward through the varicose saphenous system. Proof of this statement is apparent with (1) the Trendelenburg and Perthe tests, (2) hipodol injection of varicose veins, (3) skiodan injection of varicose veins, and (4) blood pressure experiments.

B. The theory of the reversed flow of blood in varicose veins and its mechanics should be applied in the treatment of every case. The actual technique employed in the individual case should vary with the case at hand.

C. The entire condition of one or both legs should be treated completely at the first sitting to insure a better result. Theoretically there should be less danger of emboli formation with this technique. It is essential also that the saphenous vein be thrombosed up to the saphenofemoral ring to produce a lasting result.

D. As far as our search of the literature has revealed this is the first report of any work recording the blood pressure in the deep femoral in the human.

OBSTRUCTIVE PULMONARY EMPHYSEMA AND COLLATERAL RESPIRATION

C M VAN ALLEN, M D , PEIPING, CHINA

Department of Surgery, Peiping Union Medical College Peiping China

OBSTRUCTIVE emphysema of the lung was first described by Iglauer 20 years ago and has become well recognized since then by bronchoscopists and roentgenologists. Manges recorded 33 proved cases from his experience up to 1922. Jackson has written particularly extensively on the subject. This type of emphysema is clinically important because of its alarming effects and because its presence and distribution give reliable evidence of the existence and location of bronchial obstruction.

The purpose of this paper is to point out certain newly studied characteristics of the condition, particularly the tendency of the emphysema to result only from lobar bronchial obstruction. The cause for the failure of lobular bronchial obstruction to produce emphysema is assigned to collateral respiration, and that function of the lungs will be explained. The various other aspects of obstructive emphysema also will be discussed briefly.

ETIOLOGY

Iglauer and Jackson have observed bronchoscopically in man that a foreign body or neoplasm in a bronchus may produce valvular obstruction of a sort which permits air to pass only during inspiration. In some cases the object rolls or flaps with the air currents against an isthmus situated centrally to it in the bronchial lumen. In others the object is stationary and the respiratory movements of the bronchial wall produce the valvular action, for, with the dilatation of the bronchus that occurs at inspiration, the lumen opens slightly on one side of the object, and with the contraction that takes place at expiration, the lumen closes tightly around it. Wessler and Jaches have described a case with obstruction by pressure from an enlarged peribronchial lymph node, where presumably the respiratory movements of the bronchus also affected the valvular action. In any case, the

action brings about superabundant accumulation of air in the obstructed lobe or group of lobes and emphysema of those parts. The emphysema usually remains until the obstruction is relieved (for 3 months in one instance), and then it quickly disappears. However, emphysema may appear only during periods of exertive breathing, and it is always accentuated by this exertion. In most reports the bronchus in which the obstruction was found is not explicitly named, but the distribution of the emphysema is given and is said to correspond exactly to the territory supplied by the obstructed bronchus. One entire half of the lungs is reported to have been emphysematous in the majority of cases and single lobes in the rest, the right side being the more frequently involved. Careful search of the literature fails to disclose an instance with only a fraction of a lobe emphysematous.

SYMPTOMS

The development of emphysema is marked by a distressing sense of suffocation. Dyspnoea, cyanosis, and tachycardia appear and may become very pronounced particularly when the patient exerts himself unduly to breathe, as in struggling and crying. Then death may result. The symptoms tend to subside during sleep or other periods of relaxation. Additional symptoms relate to pulmonary infection, tumor metastasis, etc., rather than to the emphysema, and are not pertinent to the present account.

DIAGNOSIS

Recognition of the nature of the condition is assisted by a history suggesting cause for bronchial obstruction, by the symptoms and by certain physical and roentgenological signs. Physical signs include limitation of costal and diaphragmatic movements, hyperresonance to percussion, and reduction of breath sounds, on the side of the chest with emphysema,

also exaggeration of respiratory movements and breath sounds on the other side. The heart is found displaced away from the emphysematous lung. Rarely a clicking sound produced by the valve is audible. Fluoroscopic inspection reveals increased size and radiolucency of the affected lobe or lobes, with displacement of the heart and depression of the hemidiaphragm. The ribs and diaphragm on that side move during respiration little or none at all while those on the other side move exaggeratedly. The heart has a peculiar pendulous motion swinging toward the affected side with inspiration and away from it with expiration. The difference in radiolucency and the visceral displacements are also to be seen in the roentgenogram and they are especially pronounced if the film is exposed at expiration. The alterations in diaphragmatic, costal and cardiac movements are represented in the film as well if the double exposure method of Jung and Van Allen is used. Acute compensatory emphysema as for instance that which occurs with massive pulmonary atelectasis, is differentiated from this form principally by the circumstances in the former that the diaphragm and ribs move more extensively on the side of the emphysema than on the other side and that the heart swings toward the emphysematous lung at expiration and away from it at inspiration. There is no other diagnostic roentgenological difference than this in many cases.

TREATMENT

Respiratory sedatives are given and the patient is kept as quiet as possible until bronchoscopic examination is made. The obstruction is relieved at the bronchoscopic examination by removal of the occluding body or by dilatation of the lumen. The therapy of the pulmonary infection and other complications of the bronchial obstruction is beyond the scope of this writing.

EXPERIMENTAL STUDIES

Obstructive pulmonary emphysema was produced in dogs by Hoover in 1922. He introduced into the right primary bronchus a metal ring containing a valve. This permitted the passage of inspired air only and

after a few respirations the entire right lung became enlarged and emphysematous.

Lindskog and Van Allen recently studied the aerodynamics and other mechanical principles of bronchial obstruction of all types in dogs. Some of their data pertain to valvular obstruction of this type and here the experiments were conducted as follows, briefly.

The animals were first anesthetized and tracheotomized. A long slender cannula of special design was introduced through the trachea into the stem bronchus of the right lower lobe and was fixed there by dilating its end. The bronchial tree of the entire lobe was thus extended separately to the outside. Valvular obstruction was applied by connecting the cannula to a water valve of the kind illustrated in Figure 1 at II. A manometer was also connected to the cannula. A second manometer was connected by another cannula to the pleural cavity. The breathing was rendered light and regular by carrying the animal in deep surgical anesthesia. For about 5 minutes at the beginning it was noted that air entered quite abundantly through the valve at every inspiration and that the pressure within the obstructed bronchi rose progressively. Then the rate of admission of air declined rapidly until very little air entered, only one or two bubbles every three or four breaths, and this rate remained unchanged also, the intrabronchial pressure ceased to climb and held to the elevated position it had reached. The intrapleural pressure thus far showed no appreciable alteration. After observing the situation for 1 hour and noting no change in these factors, the dog was caused to breathe deeply by lightening the anesthesia to the excitement stage. This brought about a marked increase in the amount of air entering at the valve and rapid elevation of both intra-bronchial and intrapleural pressures. After a few respirations the expiratory intrapleural pressure had reached nearly 1 atmosphere pressure. Then, although deep breathing was continued, the rate of entry of air decreased as before and the pressures remained at their new levels. These conditions showed no further tendency to change. After about 30 minutes, the anesthesia was made deeper and the breathing lighter. Air stopped entering at once and the pressures began gradually to fall, until after a few minutes the intrabronchial pressure had descended to its first elevated level and the intrapleural pressure had reached normal. Air then began again to pass through the valve, one or two bubbles every third or fourth breath, and conditions became stationary once more. The dog was killed by injecting ether intravenously. With complete muscular relaxation of death, both pressures rose immediately to much higher points than those previously obtained, the intrapleural pressure being well above that of the atmosphere. Autopsy showed the right lower lobe greatly overinflated, the right half of the

diaphragm depressed, the heart displaced markedly to the left, and the other lobes correspondingly compressed

It was concluded that emphysema is produced by lobar valvular obstruction of this type, that the degree of overinflation of the lung is determined directly by the depth of breathing and is stationary with a fixed respiratory depth, that after stationary conditions of inflation have been reached with a fixed respiratory depth, air enters the valve only in sufficient amounts to make up for absorption, that the pressure in the obstructed bronchi rises in proportion to the degree of overinflation, that the general intrathoracic (intrapleural) pressure is not altered unless extreme overinflation occurs, and that the relative stability of the general intrathoracic pressure is due to automatic accommodation by expansion of the thoracic parietes

In other experiments of the kind, these workers introduced the cannula farther into the bronchus of the right lower lobe and fixed it at a point peripheral to the first branch of the lobe, so that lobular obstruction was obtained. Here the results were very different for air entered abundantly through the valve at every inspiration for indefinitely long periods of time and the intrabronchial and intrapleural pressures suffered no mean elevation no matter how deeply the dogs were caused to breathe. Autopsy showed no overinflation of the lung. After many trials it was concluded that obstructive emphysema cannot be produced in a part of a lobe alone.

The fact that emphysema may be produced by lobar but not by lobular valvular obstruction has also been demonstrated roentgenographically in new experiments

Each of three dogs was anesthetized and tracheotomized. A slender rubber tube tipped with a short glass cannula, was introduced into the right primary bronchus. Positive pressure breathing was then administered and the chest was opened on the right by intercostal incision. In the case of one dog the right primary bronchus was then isolated and encircled with a ligature at a point just central to the branch leading to the upper lobe. By tying the ligature the bronchus was fixed to the glass tube within it and the entire right lung was thus separately cannulated (see Fig 1, A). With the second dog, the stem bronchus of the right lower lobe was encircled with a ligature, the tube was maneuvered

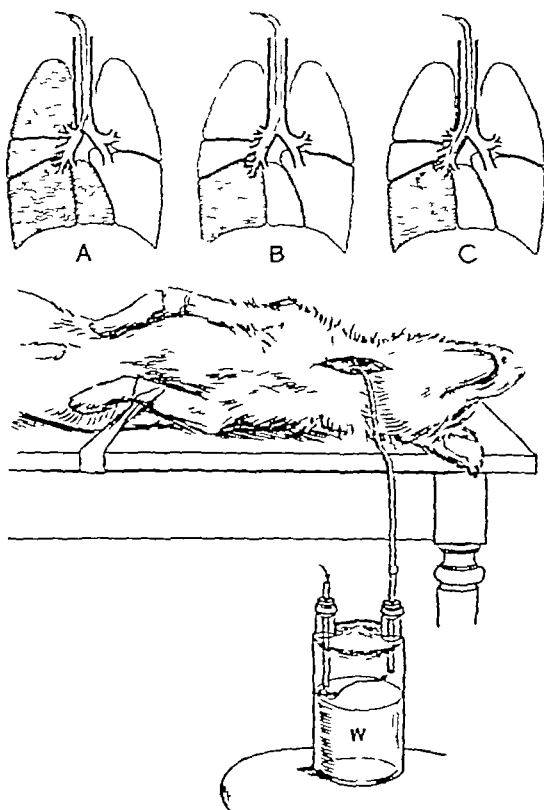


Fig 1 Experimental method for producing valvular bronchial obstruction, as described last in the text. Below, Sketch of the anesthetized and tracheotomized dog with the tube from the bronchial cannula emerging from the trachea and extending to the obstructing water valve, W. Arrows indicate the direction of flow of the respired air through the valve. Above, A, B, and C diagrams of the lungs of the three dogs used, showing the points of fixation of the bronchial cannula and the areas of lung (dotted) so obstructed. Arrows above indicate the direction of flow through the tube and cannula. A, Lobar obstruction including the entire right lung, B, lobar obstruction, including the entire right lower lobe, C, lobular obstruction, including about nine tenths of the right lower lobe. Arrow below shows the collateral path of escape of air from the obstructed lobules

to that position, and the ligature was tied, so that the whole lobe was separately cannulated (see Fig 1, B). With the third dog, the stem bronchus of the right lower lobe was dissected free of parenchyma far enough toward the periphery so that a ligature could be passed around it at a point peripheral to the first branch of the lobe. The tube was maneuvered to that place and the ligature was tied. This produced separate cannulation of more than nine tenths of the lobe, leaving the remaining fraction free (see Fig 1, C). After ligation in each case, the lungs were fully expanded to exclude pneumothorax



Fig. 2. Roentgenograms of the chests of the three dogs (Fig. 1) showing the effects of valvular bronchial obstruction for 1 hour. A and B. Lobar obstruction, with emphysema of the entire right lung and of the right lower lobe respectively. Note the displacements of the heart and right hemidiaphragm. C. Lobular obstruction, without emphysema of the obstructed part (nine-tenths of the right lower lobe). Note the normal positions of the heart and diaphragm.

and the chest was closed. Artificial breathing was then stopped and a roentgenogram was taken. This showed the chest to be normal except for the presence of the tube and slight distortion of two ribs at the wound. The outer end of the tube was now connected with a water valve (see Fig. 1). By lightening the anesthesia the dogs were caused to breathe deeply. In the cases of the first two dogs (lobar obstruction) air entered the valve abundantly with every inspiration, for a few minutes. Then the rate of entry fell off and soon became constant at three or four bubbles of air per minute. X-ray examination at this time revealed the characteristic signs of obstructive pulmonary emphysema, involving the whole right lung in the first dog and the right lower lobe in the second. The roentgenograms are reproduced in Figure 2 at A and B. With the third dog (lobular obstruction) air entered the valve abundantly and without any reduction in rate. After 1 hour X-ray examination showed no evidence of emphysema (see Fig. 2 C). The dogs were sacrificed and the roentgenographic findings were proved to be correct at autopsy.

The explanation for these differences in the effects of lobar and lobular forms of valvular bronchial obstruction evidently lies in the fact recently demonstrated by Van Allen, Lindskog and Richter that collateral connections exist between the airways of the lobules throughout the lobe but not between the airways of adjacent lobes. In their invest-

igations the lobular units of the bronchial tree were found not to be independent of each other at the periphery as has been hitherto commonly supposed, but to be joined together by minute openings between the alveoli where the interlobular septa are incomplete. It was discovered that these connections are utilized to convey air during respiration to and from a division of a lobe when the bronchus of that part is totally obstructed. The function is termed collateral respiration. Chin and Van Allen and Van Allen and Jung demonstrated in both man and dog that one of the roles of collateral respiration is to prevent atelectasis after bronchial obstruction. Atelectasis failed to develop with total obstruction of a lobular bronchus even after long periods of time, whereas total obstruction of a lobar bronchus caused atelectasis within 24 hours. Collateral respiration was found to fail and atelectasis to be produced with lobular obstruction only when the parenchyma of the free lobules in the same lobe was consolidated from pneumonia or other cause. The existence of collateral interlobular connections explains well the situation in regard to valvular bronchial obstruction that has been set forth

above, for in lobular obstruction the air which enters by the bronchial valve with each inspiration is free to leave the obstructed lobules collaterally with each expiration, without altering the degree of pulmonary inflation, while in lobar obstruction collateral escape is not provided for the air accumulates, and overinflation results

Referring again to the clinical aspects of obstructive pulmonary emphysema, it becomes clear why the condition has been seen only with lobar distribution. Furthermore, it is evident that the presence of normal inflation of the lung cannot be taken in any case as a guarantee of unobstructed bronchi. Also, the practice of keeping the patient from undue exertion in breathing until the obstruction is removed receives theoretical support

SUMMARY

The etiology, symptomatology, diagnosis, and treatment of obstructive pulmonary emphysema are briefly discussed. It is noted among other points that in all cases which have been reported the distribution of the emphysema was lobar. Animal experiments are described which show that the condition can be reproduced in one or more whole lobes of the lung but not solely in lobular divisions. The latter fact is accounted for by reference to collateral respiration. Collateral respiration is explained and its general significance is discussed. Other experimental data are recounted to bring out additional characteristics of obstructive emphysema, particularly the fact that the overinflation of the lung is

proportional to the depth of breathing and is not otherwise progressive. The relation of these facts to clinical diagnosis and treatment of the condition is indicated.

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CARCINOMA OF THE GALL BLADDER AND BILE DUCTS¹

F STARR JUDD M.D. F.A.C.S. ROCHESTER MINNESOTA

HOWARD K. GRAY M.D. ROCHESTER MINNESOTA

Fellow in Surgery The Mayo Foundation

FROM 1907 to 1930 inclusive 22,365 operations were performed at The Mayo Clinic on the gall bladder and biliary tract. In 15,422 of these cases stones were present either in the gall bladder or in the ducts. In the same period 312 operations were performed for malignant conditions of the gall bladder or ducts: 100 of the carcinomata were in the ducts, and 212 were primary in the gall bladder. The incidence of malignancy in the gall bladder or ducts in the cases in which operation was performed for any condition of the gall bladder or biliary ducts was 1.4 per cent.

AGE AND SEX

In our series of 212 cases of primary carcinoma of the gall bladder 157 (74 per cent) occurred among women. Zenker reported 72.9 per cent among women. Naunyn 83 per cent and in Munser's series of 98 patients 75 were women. Smithies reported a greater frequency in men, the proportion being 16 to 7.

Carcinoma of the bile ducts is more common among male patients, although the difference is not so marked. Fifty-eight of our 100 cases (58 per cent) occurred among men. In Rolleston's series of 90 patients with carcinoma of the bile ducts, 55 were males and 35 were females. A similar incidence was reported by Devic and Gallavardin who found the condition in 30 males and 16 females.

The average age of our 312 patients was 57.1 years. There is no appreciable difference in the age at which carcinoma of the gall bladder and of the extrahepatic ducts is observed. Both occur most frequently between the ages of 50 and 70 years. Of the 312 patients, 0.9 per cent were aged less than 30 years, and the age incidence by decades from that period was as follows: 30 to 40 years, 4.7 per cent; 40 to 50 years, 14.9 per cent; 50 to 60 years, 40.3 per cent; 60 to 70 years, 33.1 per cent; and 70 to 80 years, 6.0 per cent. The youngest patient was 23 years of age and the oldest 78 years.

CLINICAL PICTURE

There is no distinct clinical picture of carcinoma of the gall bladder or of the biliary ducts for the symptoms presented are dependent to a great extent on the situation of the lesion, its extent and the changes associated with it. The most frequent complaint is of jaundice, which in contradistinction to jaundice caused by extrinsic mechanical obstruction of the bile ducts, is usually associated with pain. Vague gastric symptoms, characterized by belching, bloating or milder forms of indigestion are frequently complained of. Pain is chiefly in the right upper abdominal quadrant. This pain may be projected to the back, between the scapulae or to the right shoulder and in some instances it extends across the abdomen to the left side. Frequently it originates in the epigastrium, and is similarly projected. It may be localized in the lower portion of the abdomen or in the right side of the thorax, but relatively rarely. The pain has no definite relationship to meals, nor is there any definite relationship to the quality or quantity of food. Pain at night is rare although if the condition is associated with cholelithiasis, there may be some nocturnal distress. Morphine is not infrequently required to relieve the pain particularly that of typical biliary colic, which undoubtedly is a result of the presence of stones rather than of the malignant process *per se*. Changing the posture, and the application of external heat to the region, are of little benefit in any case.

Lancereaux has divided cases of malignancy of the gall bladder into a biliary form characterized by belching, abdominal cramps, dyspepsia, jaundice, presence of an abdominal mass, and fever and an hepatic form, of insidious onset, short duration and accompanied by vague abdominal pains, weakness, diarrhea or constipation, rapid enlargement of the liver and occasional slight jaundice. Rolleston divided such cases into those in which the symp-

toms are associated with pre-existing cholelithiasis those in which the symptoms are due to the local effects of the disease, and those in which they are due to invasion of adjacent parts by the growth, and to metastasis in the liver, peritoneum, and elsewhere

According to our experience, if the lesion is in the common bile duct, the onset of symptoms is insidious, and the first symptom generally is jaundice, which is usually accompanied by pain. The clinical picture is then one of obstructive jaundice, and varies with the situation of the growth and other associated conditions, such as infection, stones, or pancreatitis. There may be a sudden onset of rather typical biliary colic, which would suggest an impacted stone, but which may occur even in the absence of choledocholithiasis, associated cholangitis or pancreatitis. Infrequently there are chills and fever, and a history of recurrent attacks is not uncommon.

In the 312 cases, the duration of the symptoms concerning which the patient complained in most cases was less than 6 months, and in one-half of these the symptoms had persisted for 2 months or less. In the remainder of the cases there may have been considerable distress in recurrent attacks for a period of years, but these were undoubtedly due to associated conditions rather than to the lesion in question. The degree of jaundice was usually marked, the concentration of bilirubin often reaching as much as 35 to 40 milligrams in each 100 cubic centimeters of serum. A definite clinical diagnosis was exceedingly difficult.

W. J. Mayo has mentioned the following points in connection with clinical diagnosis of malignant neoplasms in the gall bladder: a hard tumor in the region of the gall bladder, absence of rigidity unless the peritoneum is involved, progressive loss of flesh and cachexia, a nodular tumor if the liver is involved, and jaundice if the ducts are involved. In our series of cases, however, a palpable tumor in the region of the gall bladder was observed relatively infrequently, and most often the clinical diagnosis was cholecystitis with cholelithiasis.

The importance of early diagnosis cannot be overestimated. Pallin recently analyzed 52 cases of carcinoma of the bile ducts. Anas-



Fig. 1. Carcinoma of the cystic duct with obstruction of the common duct. Cholelithiasis. One stone impacted in the cystic duct.

tomosis was done in 9 cases, and in 7 the ducts were drained. Twenty-five of the 31 patients who were operated on died almost immediately. In one-half of the cases, deaths were attributed to postoperative hæmorrhage, and 2 to anuria. Injury from the bile in the blood was responsible for 18 of the 25 fatalities. Pallin stated that danger from cholæmia is seldom great until the jaundice has persisted for from 3½ to 4 weeks, and concluded, therefore, that operation should be performed in not more than 3 weeks after severe, persisting jaundice has been suspected of arising from malignant disease.

SURGICAL TREATMENT

A satisfactory method of dealing with cases in which carcinoma of the gall bladder or biliary ducts is suspected is to institute an immediate short period of observation in hospital. During this time duodenal drainage is



Fig. 1. Closer view of Figure 1. Occlusion of the common duct by the growth in the cystic duct.

attempted, and solution of glucose and sodium chloride solution with the addition of calcium chloride, is administered intravenously. Transfusion of blood once or twice prior to any contemplated operative procedure is of distinct benefit. If no bile is obtained after repeated efforts at duodenal drainage and if the concentration of serum bilirubin remains stationary or shows any tendency to increase, that complete biliary occlusion has occurred is a logical deduction, and immediate operation must be done to re-establish adequate flow of bile. On the other hand, if bile is obtained through the duodenal tube, and the concentration of serum bilirubin shows a tendency to decrease, operation may be postponed until the value for serum bilirubin has become low and constant and the general condition of the patient is as satisfactory as possible.

The surgical treatment of patients with malignant disease of the gall bladder or biliary ducts is either palliative or radical. Of the 312 cases studied in this series, exploratory operation with removal of a small bit of tissue for diagnosis in a few cases, was the only surgical procedure carried out in 172 (55.1 per cent). In 59 cases it was possible to remove the gall



Fig. 3. Same as Figure 1. Calculi have been removed to demonstrate the increased thickness of the wall and the trabeculation of the gall bladder. The malignant process has not extended above the cystic duct.

bladder. In 43 cases cholecystostomy only was done and in 9 the gall bladder was removed and the common bile duct drained at the same time. Anastomosis was made in 27 cases. In the majority of them, cholecyst gastrostomy was carried out, cholecystoduodenostomy was performed in 9 cases, and cholecystjejunoostomy in 1 case. The ampulla of Vater was resected in 3 other instances.

The type of surgical treatment indicated depends entirely on the situation and extent of the growth. Immediate establishment of biliary drainage is essential and should be carried out before radical resection is attempted. A good example of what one may accomplish is given in a case of carcinoma of the ampulla of Vater which was observed 4 years ago. The first operation in this case consisted of choledochostomy with drainage of the common bile duct for a period of 2



Fig 4 Carcinoma of the gall bladder, with metastasis to the liver Occlusion of the cystic duct and the common duct Cholelithiasis

months Transduodenal resection of the ampulla was then done Unfortunately, there was recurrence at the site of the original lesion, and obstruction to the biliary flow necessitated cholecystgastrostomy The recurrent lesion continued to enlarge and finally produced duodenal obstruction, so that a fourth operation was necessary, at which time posterior gastro-enterostomy was performed The final flow of bile in this case, therefore, was through the gall bladder and into the stomach where it united with the food, and from the stomach through the gastroenteric stoma

Early lesions in the gall bladder, of course, necessitate cholecystectomy Rather early metastasis occurs if the lesion is confined to the gall bladder, for the lymphatic drainage from this viscus is profuse Springer advised for middle-aged persons who have complete and persistent obstructive jaundice, that cholecystenterostomy be performed first Radical resection is performed after 4 or 5 weeks if such a procedure is possible

Carcinoma of the cystic, common, or hepatic duct may be treated by resection of the involved parts, or by the palliative procedure of establishing biliary continuity by means of one of the methods of biliary intestinal anastomosis Cholecystostomy only may be done to relieve infection and to decrease constriction in the duct below by lessening the spasm



Fig 5 Photomicrograph of a section of the wall of the gall bladder illustrated in Figure 4 Diffuse infiltration by islets of adenocarcinomatous tissue which has a markedly invasive character (X150)

CALCULI AS AN ETIOLOGICAL FACTOR

As little is known regarding the cause of malignancy of the gall bladder and the bile ducts as is known of carcinoma in general The frequent association of gall stones with malignancy of these structures (Figs 1, 2 and 3) has led many writers to believe that the chief causal factor is local irritation In the 212 cases of carcinoma of the gall bladder that are reviewed in this report, stones were present in 137 (64.6 per cent) Interesting experimental work along this line has been done by several observers

Kazama was the first to insert foreign bodies into the gall bladder in order to produce carcinoma He experimented on the dog, rabbit, and guinea pig Of the foreign bodies which he used, some had a purely mechanical action, among these were stones, sutures, and pieces of vesicular mucosa He obtained from his research only the knowledge that by inserting small stones in the gall bladder of the guinea pig, in a relatively short time, papillomatous formations and adenocarcinoma



Fig. 6. Cross section of the liver through a region including carcinoma of the gall bladder and multiple metastatic growths in the liver.

with metastasis could be produced. In the 30 animals he produced 4 tumors, with metastasis in the thoracic wall, the intestine, and the liver. From this he concluded that the gall bladder of the guinea pig is an elective organ for the study of experimental carcinoma.

Leitch confirmed the results obtained by Kazama and reported in detail his experiences. He inserted in guinea pigs, calculi, small sterilized stones, and pellets of tar. Of 35 animals operated on 3 died quickly of hemorrhage, 17 died after a period of 15 days to a year and 15 lived even after 15 months. Results of necropsy of 3 guinea pigs are illustrative of the changes found. A year after insertion of the calculus the gall bladder of one animal was much thickened and adherent to the liver and microscopically there was a layer rich in cells in which were buried tubular formations. At other points tubules were large, sometimes irregular and covered with several layers of long cylindrical cells. In the second animal examined also a year after insertion of a small stone, there were perivascular adhesions to the liver to the intestine and to the omentum, and the gall bladder was transformed into a thick mass. Microscopically the wall was covered with epithelium which had proliferated inward into dense connective tissue. At certain points the epithelium touched the vesicular cavity and was of the pavement type. The adherent omentum was infiltrated with carcinomatous cells. Leitch estimated that he found carcinomatous lesions in 8 guinea pigs.

Barlow introduced a new factor in the pathogenesis of carcinomata of the gall bladder. He demonstrated that the calculi taken



Fig. 7. Carcinoma of the gall bladder with invasion of the common and hepatic ducts. Metastasis to the liver cirrhosis of the liver and healed duodenal ulcer.

from a carcinomatous gall bladder were radioactive, and he thought that this radio-activity was the cause of the carcinoma. Delbet and Godard have undertaken to verify the conceptions of Barlow. Calculi were taken from the carcinomatous vesicles of human patients and were submitted to examination by La Borde who was unable to discover any radio-activity. However these two observers believed that other indeterminate factors may give to these calculi a peculiar cancerigenic power. In order to verify this they undertook two series of comparative experiments. In one series, calculi taken from gall bladders of man some carcinomatous and others not were inserted in the bladders of guinea pigs. In addition part of the pigs of each series was submitted to injection of tar. Histological study of these gall bladders after varying lengths of time, failed to produce the characteristic picture of carcinoma, and the conclusion that these two observers have made fails to confirm the findings of Kazama and Leitch.

PATHOLOGY

According to Ewing carcinoma of the gall bladder appears in three main forms (1) villous, papillomatous, or fungating (2) gelatinous, and (3) diffuse flat and infiltrating



Fig 8 Carcinoma of the gall bladder, with metastasis to the liver Obstruction of the common duct by carcinoma Cholelithiasis

The disease first appears as a papilloma, or as a flat induration, or an eroded ulcer, and the situation is usually at the fundus, the neck, or at the cystic duct. The papillary form grows out into the bladder as a coarse, villous, or solid fungating mass which eventually distends and completely obliterates the lumen of the gall bladder. According to this observer early papillary tumors are rarely seen, but may appear as fragile, villous, or warty growths in a distended cavity. These may grow along the cystic duct into the hepatic ducts or into the common bile duct.

Gelatinous carcinomata infiltrate the wall, fill the cavity of the gall bladder, and early metastasis to the liver or direct extension oc-

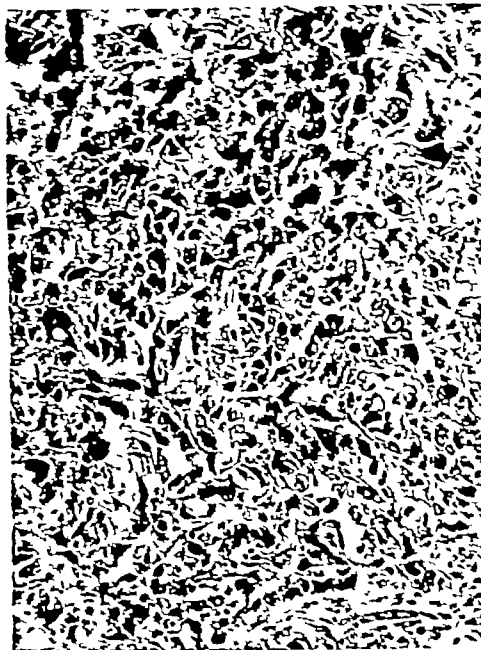


Fig 9 Photomicrograph of a section of the bed of the gall bladder shown in Figure 8. Irregularly arranged and shaped cells, some are arranged in structures which roughly simulate acini. Numerous mitotic figures ($\times 140$)

curs. Kaufmann stated that, disregarding the stomach, the gall bladder is the most common source of gelatinous carcinoma. Infiltrating tumors originate in the submucous tissues or as an ulceration in the mucosa. The wall of the gall bladder is infiltrated at an early period, and becomes greatly thickened and contracted. According to Rolleston, the majority of infiltrating tumors are of the scirrhous type, converting the gall bladder into a hard, contracted mass, without appreciable increase in bulk, extension to adjacent viscera is not uncommon. Metastasis is usually to the liver (Figs 4, 5, 6, 7, 8, and 9), abdominal nodes, and peritoneum. Beadles and West have described extensive enlargement of mediastinal and supraclavicular nodes. Warthin stated that metastasis to the suprarenal glands may give rise to cutaneous pigmentation, suggesting that of Addison's disease.

Bland-Sutton stated that carcinoma may arise in the epithelium in any of the bile ducts in the liver, but that it more commonly arises in the excretory apparatus than in the intra-

hepatic system. When the disease arises in the small intrabepatic ducts, it is, for practical purposes, primary carcinoma of the liver. According to this observer carcinoma of the excretory apparatus of the liver is frequently seen in the hepatic duct at the juncture of the hepatic and common bile ducts in the common duct, and in the ampulla, but it arises with greater frequency in the gall bladder.

In 1921 Magoun and Renshaw reviewed the cases of malignant neoplasia in the gall bladder that had been observed in The Mayo Clinic since 1907. Within this period primary malignant growths, confirmed by pathological examination, occurred in 84 cases. Of these 82 were carcinomata, 1 was an epithelioma and 1 a lymphosarcoma. The following year Renshaw reviewed the cases of carcinoma of the extrahepatic bile ducts during the same period as that of the preceding study in 20 cases the diagnosis of primary carcinoma of the bile ducts was confirmed by pathological examination at The Mayo Clinic. Eight of the carcinomata were of the adenomatous type 2 of the papillary type, and all had columnar cuboidal, or spheroidal cells. Grossly they varied from the annular constricting type to the flat diffuse and occasionally villous type.

In the series we are studying, malignancy of the gall bladder was definitely proved in 165 cases. Carcinomata occurred in 140 cases, 2 of which were definitely described as being of the colloid type. A combination of squamous cell epithelioma and adenocarcinoma occurred in 15 cases, a papillary form of adenocarcinoma in 5 cases, and squamous cell epithelioma in 4 cases. As in the cases previously reported by Magoun and Renshaw the fundus was no more frequently involved than was the pelvis. In one additional case lymphosarcoma involved both the fundus and the pelvis.

Again in our series, in 51 cases the diagnoses of primary carcinoma of the bile ducts were confirmed by pathological examination. In 28 cases the lesion occurred in the common duct the diagnosis in all of these cases was carcinoma and in 3 of them the growth was of the papillary type. Nine cases of carcinoma of the ampulla were observed 1 of which was colloid

in nature and another papillary. Carcinoma of the hepatic ducts occurred in 8 cases, 1 of which was papillary and in 7 cases the growths arose from the cystic duct all of which were carcinomata.

In 1927 Webber made an effort to determine a relationship between the length of life of patients after operation and the grade of malignancy of primary carcinomata of the gall bladders that were removed. Thirty cases of primary carcinoma of the gall bladder were studied but 4 of the patients died in hospital, leaving 26 for further investigation. In 12 of these in which the growths were graded 2 or less, the patients lived an average of 2 years and 10 months after operation. Fourteen patients with carcinomata graded 3 or more lived an average of only 4.8 months. Of 12 tumors graded 2 or less, 4 were found at operation associated with growths or microscopic evidence of extension or metastasis. Of 14 tumors graded 3 or more 13 were found at operation to be associated with similar evidence of extension or metastasis. Of all cases of carcinoma of the gall bladder and biliary ducts observed in The Mayo Clinic, 65 per cent of those in which the specimen has been subjected to grading have been graded 3 or more.

SUMMARY

A pathological and clinical study of 312 cases of primary malignancy of the gall bladder and 100 cases of malignancy of the extrahepatic biliary ducts, has been presented. This represents 1.4 per cent of all cases in which operation for lesions in the gall bladder or biliary tract were performed during the same period as that represented by the cases studied. Of cases of carcinoma of the gall bladder 74 per cent occurred in women. Of cases of carcinoma of the bile ducts, 51 per cent occurred in men. The average age of our entire 312 patients was 57.1 years. Seventy-three per cent of them were between the ages of 50 and 70 years. The youngest patient observed was 23 years of age and the oldest 78.

The clinical picture of carcinoma of the gall bladder or biliary ducts is not distinct and depends entirely on the situation of the lesion and on associated conditions such as infection, the presence of stones, and pancreatitis. The

majority of patients present symptoms of less than 6 months' duration. However, in many instances symptoms persist for many years, and, during the whole period, disease of the biliary tract should be suspected. Of the symptoms, the most frequent is jaundice associated with pain in the right upper abdominal quadrant.

The surgical treatment of carcinoma of the gall bladder or biliary ducts may be palliative or radical. Exploratory operation only was possible in 55.1 per cent of the 312 cases. Cholecystectomy was performed in 59, cholecystostomy in 42, cholecystectomy and choledochostomy in 9, and an anastomotic operation in 27.

Stones were present in 64.6 per cent of the cases in this series in which the gall bladders were the site of malignant growths. Carcinoma occurred in 140 cases, squamous cell epithelioma and adenocarcinoma in 15 cases, a papillary form of adenocarcinoma in 5 cases, squamous cell epithelioma only in 4 cases, and lymphosarcoma in 1 case of 165 lesions of the gall bladder which were proved to be malignant. Of 52 lesions of the bile ducts, all of which were proved to be malignant, all were found, on histological examination, to be carcinomata, and the common duct was the most frequent site. In our series, 65 per cent of all growths which were graded proved to be of grade 3 or more. Of patients with tumors of the gall bladder graded 3 or more, in Weber's series, the average length of life was only 4.8 months. Carcinoma of the ducts or ampulla usually imposes a still more serious prognosis.

Whether stones may be an etiological factor in the production of malignancy of the biliary tract is not known. The high incidence of stones in association with this condition, however, cannot be discounted and presents an important factor in deciding for or against their removal when first observed.

The importance of early diagnosis of malignant lesions of the gall bladder or biliary ducts cannot be overemphasized. Since it is impossible to recognize a distinct clinical syndrome which may accompany malignant invasions of

the biliary tract, the condition should be kept in mind, in order that treatment may be instituted while the disease is temporarily controllable if not curable.

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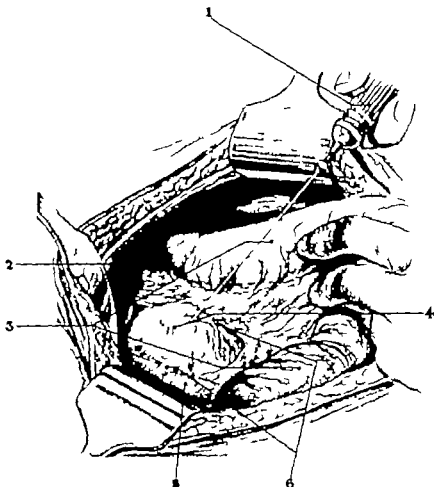


Fig. 8 Infiltration of retroperitoneal tissues by means of high pressure local anesthesia method. Formation of an omentous sheath under direct vision through incision in the lesser omentum. 1 apparatus used for high pressure local anesthesia, 2, liver, 3 stomach, 4 omentous sheath, 5 vena cava inferior, 6, margin of wound to lesser omentum.

SPINAL ZONE ANAESTHESIA—MARTIN KIRCHOFFER

CLINICAL SURGERY

FROM THE SURGICAL CLINIC, UNIVERSITY OF TUEBINGEN

SPINAL ZONE ANÆSTHESIA

PLACED AT WILL AND DOSAGE INDIVIDUALLY GRADED¹

PROFESSOR DOCTOR MARTIN KIRSCHNER, TUEBINGEN, GERMANY

WHILE spinal anæsthesia is the method of choice in operations upon the lower extremities, it is within the abdominal cavity that it becomes the ideal procedure, unapproached by any other method because it affords unparalleled relaxation of the abdominal muscles, a quiet state of the patient, and an almost complete absence of postoperative complications.

Unfortunately, this inherently splendid method has been thus far regarded as a hit or miss procedure. It has not been possible to control the extent and the depth of anæsthesia. While the anæsthesia begins in the caudal spinal roots, it can be made through the increase of the dose or through the increase of the volume of the solvent or through changing the point of the spinal puncture to spread cranialward. One cannot, however, control either the level to be reached within the dural sac or hold it at the level attained. In one instance the anæsthetic solution will not spread sufficiently high cephalad and thus an incomplete anæsthesia may result, while in another it may spread too high and cause respiratory disturbances, a fall in the blood pressure, and collapse.

Still another shortcoming may be mentioned—the relatively great differences in the sensitiveness of individuals to a calculated dose, a fact which must not be disregarded. Each patient is given a predetermined average dose which may prove unnecessarily large in one case producing toxic symptoms or death, or it may prove too small in another case resulting in unsatisfactory anæsthesia. The dose will be exactly right for only a small proportion of cases.

The recently developed method of Pitkin has not obviated these disadvantages. The statement that spinocaine only because of its viscosity and lighter specific gravity will spread cranialward or caudalward when introduced into the dural sac, depending solely upon the position of the patient, is incorrect as anyone can at any time demon-

strate upon a system of glass tubes. Spinocaine, when injected into the dural sac, can be seen to spread more often evenly to both sides without separating out because its specific gravity is different from that of the spinal fluid. I have not been able markedly to influence the spread of anæsthesia in patients either through the elevation of the pelvis or of the upper trunk. Were the proposition of Pitkin correct, it would certainly appear too dangerous—if only in the view of the variability in spinal curvatures—to depend, for the spread of so potent a solution, upon placing the diseased part or the entire body for a few minutes in an exactly prescribed degree of inclination. Pitkin's method does not discuss the question of individual dose.

We are using a new method of inducing spinal anæsthesia by means of which the anæsthetic solution can be placed at will in a definite segment of the spinal cord and maintained there, and in which the dosage is regulated to the individual patient much as it is in ether inhalation narcosis. These two conditions are arrived at in the following way:

1. With the patient placed so that the head is low and the buttocks are elevated a spinal puncture is done and a certain amount of cerebrospinal fluid is removed and replaced by an equal volume of air. The air bubble collects in the highest portion of the dural sac within the sacral bone. An anæsthetic solution, which is lighter than the cerebrospinal fluid and being oil-like is not miscible with it is injected into the dural sac. The fluid will naturally collect and take its place between the cerebrospinal fluid and the air bubble. Because it is lighter than the cerebrospinal fluid it cannot spread cephalad and it cannot pass toward the sacrum because of the lighter air.

In view of the fact, however, that the separation into three layers—the cerebrospinal fluid, the anæsthetic charge, and the air—will take place

¹Translated by Dr. George Halperin.

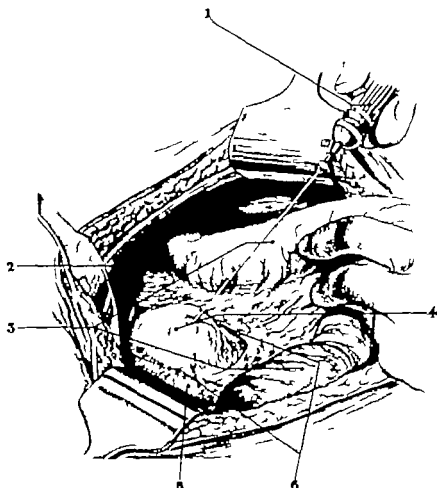


Fig. 8. Infiltration of retroperitoneal tissues by means of high pressure local anesthesia method. Formation of an omentous bleb under direct vision through rent in the lesser omentum. apparatus used for high pressure local anesthesia: 1, liver; 2, stomach; 3, omentous bleb; 4, vena cava inferior; 5, scargus of wound in lesser omentum; 6.

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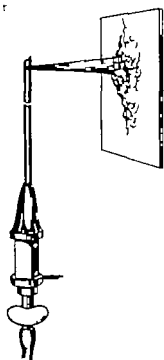


Fig. 1. Spinal puncture cannula with lateral opening. The forcibly injected fluid is seen to diffuse transversely to the long axis of the cannula.

rather slowly and incompletely if dependent alone on the slight differences in the specific gravity. It is desirable to carry out still another procedure. This consists in injecting the anesthetic solution through a special cannula the end of which is beveled off at 45 degrees and which is armed with a lateral opening just above the point (Fig. 1). The solution can be projected a considerable distance cephalad or caudad by turning the lateral opening in one or the other direction. Only the combination of this mechanical force plus gravity will insure a dependable separating out of the cerebrospinal fluid, the anesthetic charge, and the air.

Only those spinal roots which pass through the layer of the anesthetic solution will become anesthetized. The roots corresponding to the layer of air or of cerebrospinal fluid will not be thus affected. In this manner we accomplish (1) *zone anesthesia* (Fig. 10).

2. If to begin with insufficient air is injected or if some of it is aspirated, the anesthetic solution will advance in the direction of caudal roots and the zone of anesthesia will involve the lower extremities (Fig. 11). If considerable air is injected at the first or second attempt, the anesthetic

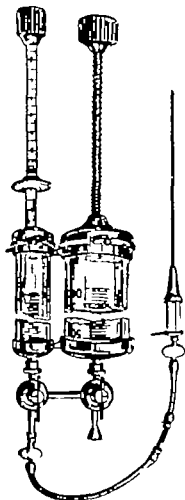


Fig. 2. The double syringes for spinal anesthesia. The large syringe is for the aspiration of the cerebrospinal fluid and for the injection of air into the spinal sac. The small syringe serves the purpose of injecting the anesthetic charge. The stopcocks of the larger and smaller syringes control the outlets. The rubber tube and the cannula are joined by means of airtight bayonet pieces. The rubber tube is provided with a capillary glass tube so that the passage of air or fluid may be observed.

charge will be driven cephalad advancing the zone of anesthesia in the same direction (Figs. 9 and 10) while the legs whose corresponding roots are protected by the area of air will retain their sensibility. In this manner we accomplish (2) a *spinal zone anesthesia* limited to the upper trunk.

3. Rather than introduce the calculated dose at once one may begin with a smaller dose, testing the skin sensibility after injection and adding

more anæsthetic if necessary, thus securing the desired depth of anæsthesia in stages and giving each patient the minimum amount of the drug, neither more nor less! We thus secure (3) controllable *spinal zone anæsthesia with individually determined doses!*

APPARATUS¹

To achieve these ends one requires special apparatus. The principal instrument is a double syringe (Fig. 2) consisting of a larger barrel of the capacity of 50 cubic centimeters for air and of a smaller barrel of 10 cubic centimeters' capacity for the anæsthetic solution. The outlet of both barrels is united by a crosspiece. Each is provided with a stopcock at the joint with the outlet of each barrel reaching beyond the stopcock. The extremity of the larger barrel expands in the form of a triangle so that nothing can be attached to it. To the end of the smaller syringe a tube armed with a bayonet metal piece may be attached. To the other end of the tube is attached the spinal puncture needle. The stopcock of the larger barrel controls (1) its own outlet and (2) that of the crosspiece. The smaller syringe stopcock controls (1) its own outlet and (2) the connection between its outlet and the crosspiece. By turning the cock one can therefore connect the larger barrel with the outside or with the puncture cannula or in the second place one can disconnect the smaller barrel from the cannula.

The piston of the larger barrel runs in a spiral groove and can be slowly moved by turning the screw. The piston of the smaller barrel is freely movable but can be set by means of a screw attachment so as to make it impossible to expel more than the desired amount of its contents.

A rubber tube 20 centimeters long is attached to the smaller syringe by means of a bayonet stopcock. Close to the other end the tube is interrupted by a short glass tube and at its end is armed with a bayonet-like metal piece which is prolonged as the special puncture cannula. The tube is strengthened at all joints by metallic bands guarding it against slipping even under considerable pressure. The special puncture cannula is 10 centimeters long, has an outer diameter of 11 millimeters, and tapers off at the bevel of 45 degrees. It is armed with a lateral opening just above its point.

The pistons, the stopcocks, and all of the joints are watertight so that no air or fluid can escape. To make them even more secure all the joints after boiling are greased with sterile vaseline before they are used. Because of the great importance of its

¹Made by the Jetter Scheerer Company

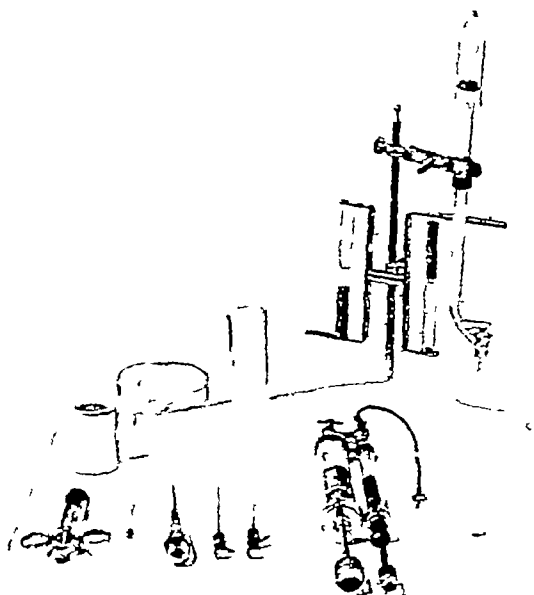


Fig. 3 Instruments and apparatus for the induction of spinal anæsthesia

being leak proof the entire system should be thoroughly tested from time to time under water. Failure to do so is likely to lead to poor results.

TECHNIQUE OF INDUCING SPINAL ANÆSTHESIA

The method is carried out in the following manner. The patient receives 0.05 grain of ephedrin (Merk, Darmstadt) instead of morphine just before the induction of spinal anæsthesia. In the case of an abdominal operation a vasano suppository (Schering-Kahlbaum, Berlin) is given one hour before. This can be augmented later by a subcutaneous injection of vasano should nausea ensue. A table is set up for the anæsthetist as follows (Fig. 3): (1) a small dish with alcohol sponges for the preparation of the patient's back for the spinal puncture, (2) a 10 cubic centimeter record syringe with a slender needle for the induction of a dermal wheal and the thicker one for the infiltration of the interspinous area, (3) 10 cubic centimeters of one-half per cent novocain-suprarenin solution for the above infiltration, (4) a three edged steel trocar for the puncture of the skin and of the interspinous ligament, (5) two special puncture needles, 11 millimeters in diameter, armed with a lateral opening, (6) a 50 cubic centimeter graduated glass cylinder for the reception of the aspirated cerebrospinal fluid, (7) two three minute hour glasses with an attached steril-



Fig. 4. Position of the patient while the anesthesia is being inducted. The body lies with the pelvis elevated at an angle of 5 degrees to the horizontal plane. Slipping from the table is prevented by strap. The double syringe is connected with the spinal needle.

izable handle (8) a freshly sterilized special double syringe with an attached rubber tube the joints of which are greased with pure sterilized vaseline. The two barrels are filled in the following way. My percaïn charge is aspirated from ampuls into the smaller syringe. The larger cylinder with the stopcock open is placed at 30, so that its effective part now contains 30 cubic centimeters of air. The stopcocks are turned so that the larger barrel is connected with the puncture cannula.

The anesthesia is inducted on the operating table draping the patient on a separate table would prove inconvenient.

The patient is placed in a lateral posture (Fig. 4) with the long axis of the body at an inclination of 35 degrees to the horizontal plane, head low buttocks elevated. The operating table is provided with an indicator or with a protractor attached to its axis, by means of which the degree of inclination can be accurately told. The slipping of the patient from the table is prevented by the use

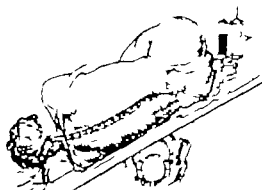


Fig. 5. The caudal portion of the dorsal sac is filled with air. The higher level corresponds with the point of the entrance of the needle.

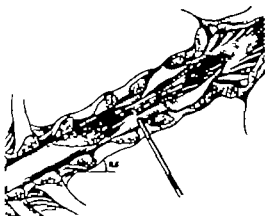


Fig. 6. "Head shot." The anesthetic charge is ejected cranialward through the lateral opening in the caudal horn in that direction. Because of its lighter specific gravity and because it is not miscible with the cerebrospinal fluid, the "charge" collects at the periphery of the cerebrospinal fluid and below the air bubbles.

of a special strap. A special assistant supports the patient and keeps his back flexed. The inclination of at least 25 degrees must remain unchanged during the induction of anæsthesia, during the operation, and after the operation until the anæsthesia has worn off. A special assistant who watches the pulse, respiration, and blood pressure and who attends to the wishes of the patient, is likewise charged with the responsibility of keeping the patient in the oblique position even during a change of posture, as for example when draping the patient for the operation either on his back or the abdomen, or in transporting him to his bed. For even a momentary raising of the head can send the air and the anæsthetic charge with it cranialward. When the area of operation is confined to one side of the body, the patient is placed during the induction of anæsthesia in an inclined position with that side up, for frequently anæsthesia spreads faster to the upper half.

The technique of induction of the anæsthesia varies, depending on whether a high anæsthesia involving the abdomen is desired, or low from the symphysis down. The anæsthetic solution should be directed cranialward from the point of entry of the needle in the lumbar region. For low anæsthesia the same should be directed caudalward. We differentiate in high anæsthesia still further between anæsthesia of the upper abdomen (operations upon stomach, bile tracts, transverse colon, spleen) and that for the lower abdomen. In low anæsthesia we differentiate between that for extremities and that for the perineal region (operations upon the prostate, anus, and the perineum).

a *Technique of high spinal anæsthesia*. Lumbar puncture here is made as high cranialward as

possible, in order to expedite the placing of the solution in the dorsal segment of the cord. Because of the possibility of injury to the cord, however, it is never introduced higher than the interspace between the first and second lumbar vertebrae.

As soon as the flow of the cerebrospinal fluid is established the double syringe with the larger barrel set at 20 cubic centimeters of air and the smaller filled with 10 cubic centimeters of percarne solution, is attached to the puncture needle by means of its rubber tube (Fig 4). From now on the syringe is never detached from the needle until the completion of the induction of the anæsthesia. The stopcock between the large barrel and the cannula is opened and the cerebrospinal fluid is aspirated into it by a backward turn of the piston. For operations in the upper abdomen (stomach, bile tracts, spleen) 25 cubic centimeters are withdrawn, while for the anæsthesia of the lower abdomen about 20 cubic centimeters are removed. A lesser amount will also suffice, a resulting excess of 10 or even 20 cubic centimeters of air will do no harm.

The stopcock of the large syringe is closed and the aspirating fluid is emptied into a measuring glass. Its piston is set at the zero mark so that the syringe will contain 50 cubic centimeters of air. The stopcock is turned so as to connect the large barrel with the cannula. From now on the stopcock is no longer disturbed. The lateral opening of the puncture needle corresponding to an indicator at its head is directed toward the buttocks.

Air is injected into the dural sac by turning the piston of the large barrel. Upon injection of 10 to 12 cubic centimeters of air more cerebrospinal fluid is aspirated by turning the piston in the

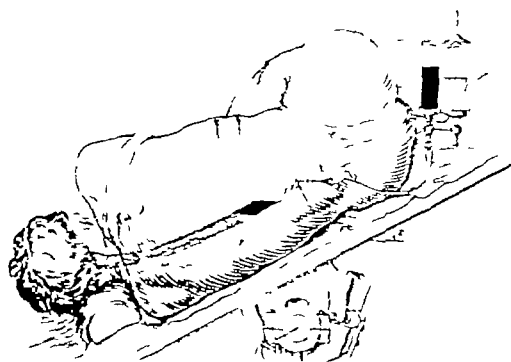


Fig 7. Additional injection of air has forced the charge into the region of the lower thoracic vertebrae. The cranial limit of the anæsthetic zone as tested by pinpricks has been demonstrated to be at the level of the navel.



Fig 8. Too much air was added. The charge has almost reached the region of cervical vertebrae. The zone of anæsthesia reached to the neck.

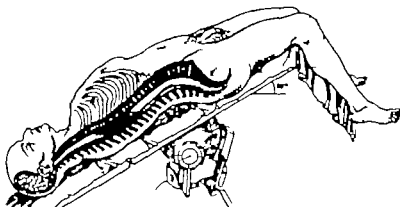


Fig. 9. The position of the anesthetic charge and the area of loss of sensation in high spinal anæsthesia.

opposite direction. If fluid appears instead of air on further aspiration, as recognized in the capillary glass tube, a few more cubic centimeters of air are injected until on still further aspiration air appears in the capillary tube. One aspirates until the first drops of fluid are observed in the glass tube. This signifies that the fluid level within the dural sac corresponds with the point of the needle (Fig. 5).

Now 5 more cubic centimeters of air are injected in order to raise the fluid level somewhat higher cranialward. In this way "a shot field" is prepared for the placement of the anesthetic charge in an area free of spinal fluid. The stopcock of the smaller syringe is now turned so as to connect it with the cannula, and the piston of the small barrel is set by the screw so that no more than 2 centimeters of the contents can be expelled. The

lateral opening of the cannula is turned cranialward. Now the piston of the small syringe is pressed forward fairly firmly down to the catch, expelling the 2 cubic centimeters of the anesthetic charge cranialward (Fig. 6). We designate this maneuver by the combative term "head shot." Immediately after the stopcock is reversed and 10 or 7 cubic centimeters of air are added depending upon whether high abdominal or low abdominal anæsthesia is desired. *At this stage the connection between the large syringe and the dural sac is closed by turning the stopcock of the smaller syringe.* That is very important for otherwise during the ensuing period of waiting the anesthetic fluid or the air under pressure will flow back into the large cylinder. The fluid contents of the smaller syringe are not affected by it. A three minute hourglass is now set up.

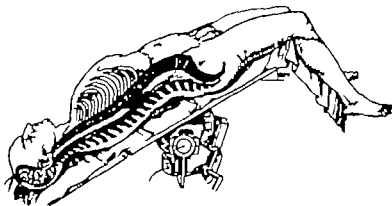


Fig. 10. The position of the anesthetic charge and the extent of anæsthetic area in low spinal anæsthesia.

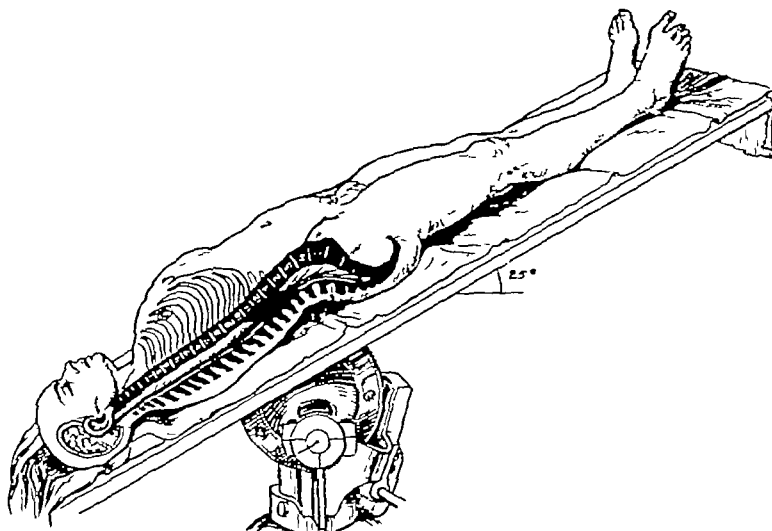


Fig 11 Position of the anæsthetic charge and spread of anæsthesia in lower extremities anæsthesia

During the "head shot" the percaine charge is projected cranialward from the puncture needle. It does not spread cranialward because of its lighter weight and because it is not miscible with the spinal fluid the special anæsthetic solution is swimming on the liquor level. The added injections of air send it still farther into the thoracic segment of the spinal cord, thus initiating the paralysis of the corresponding spinal roots (Fig 7). The roots which lie above or below the anæsthetic charge remain unaffected.

We wait full 3 minutes with the position of the patient and of the apparatus unchanged, at the end of which time the upper limit of skin anæsthesia to pinpricks is tested. If the anæsthesia has not progressed far enough cranialward, which is commonly the case, 5 more cubic centimeters of air are injected after reversal of the stopcock of the small syringe. This has the effect of sending the anæsthetic charge still further cranialward. The stopcock is once more reversed and the hourglass is again set up. The position of the anæsthesia zone is again determined and if necessary, once more regulated by the addition of air.

If the anæsthesia has been found to have reached too far in a cranial direction, as may readily happen at the very first filling in a case of an abnormally narrow spinal sac, then about 5 cubic centimeters of air are removed by turning the stopcock of the air syringe in the opposite direction (Fig 8). This will cause the anæsthetic charge to sink somewhat toward the buttocks.

The stopcock of the small syringe is once more reversed and the zone of anæsthesia again determined after a 3 minute wait.

If at first or after a secondary addition of air, the border of anæsthesia is found to be correct, then no more air is added (Figs 9 and 10). The greatest amount of air in my experience so far



Fig 12 Position of the anæsthetic charge and anæsthetic involvement in breech anæsthesia

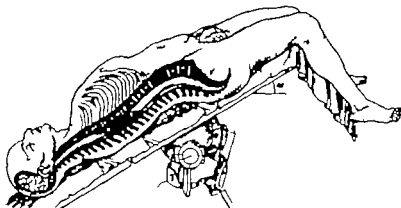


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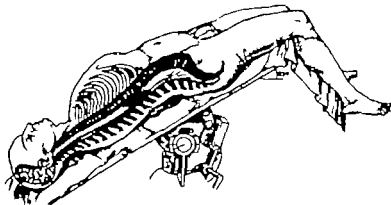


Fig. 10. The position of the anesthetic charge and the extent of anesthetic area in low spinal some anesthesia.

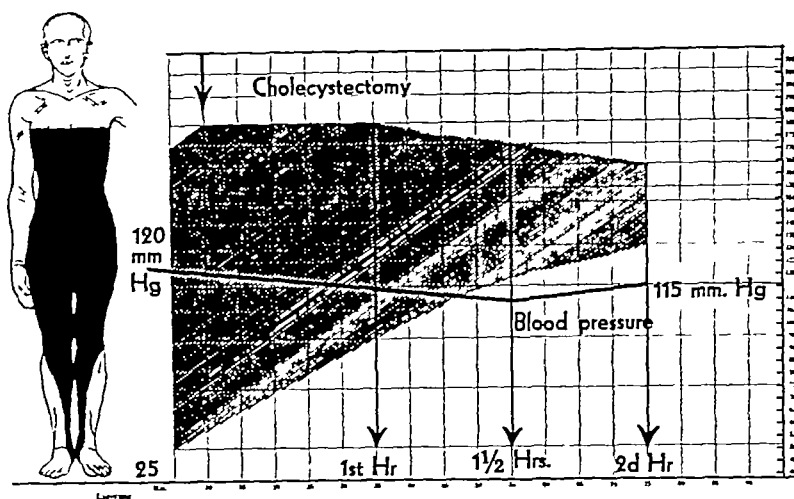


Fig 14 Time chart and blood pressure curve in high anesthesia with partial involvement of legs in a case of a cholecystectomy

minute wait. As a rule further additions of air are here seldom required. On the contrary, anæsthetic solution will be added until deep anæsthesia involves both legs.

To bring about breech anæsthesia, 5 cubic centimeters of cerebrospinal fluid are withdrawn. Three cubic centimeters of air are injected. Here with the lateral opening of the cannula directed caudad, 2 cubic centimeters of the anæsthetic charge are injected as slowly as possible, taking up from one-half to one minute. A forcible injection here, with the point of the needle within the spinal fluid and with a small air bubble, could easily force the injected fluid cranialward and mix it with the spinal fluid. This can be readily shown to take place in a mannikin. With a slow and careful injection, the charge will rise above the layer of cerebrospinal fluid and will collect between the latter and the air bubble, that is, above the cerebrospinal fluid and below the air bubble. To complete its emptying from the rubber tube, a little air is slowly injected until the fluid passes the connecting capillary tube (Fig 12). After the reversal of the stopcock of the small syringe, 3 minutes are allowed to elapse, further extent and depth of anæsthesia are secured as already described by graded additions of 5 cubic centimeters of air or of 0.5 to 1 cubic centimeter of percaine charge.

As soon as the desired extent and depth have been reached, the needle is disconnected. The puncture hole is sealed with a piece of adhesive plaster. The patient is placed in the desired position for the operation, on his back, his face, or on

his side, without, however, raising even for an instant the upper trunk or the head, and without altering the twenty-five degree inclination of the table.

CLINICAL RESULTS

My experience up to date includes 700 cases. Among these there were 500 laparotomies, of which 200 were performed for partial gastric resection and 70 for operations upon the bile tract. Correct technique and proper instruments rule out overdosing or failures. Each failure, to determine the proper dose to secure the required depth of anæsthesia or the desired upward extension is unqualifiedly the fault of the anæsthetist. For in the new method of spinal anæsthesia the anæsthetist is no longer a bungling helper but rather a careful observer, watching the dose and the effect and assuming responsibility for both the depth and the involvement, much as an anæsthetist does in inhalation narcosis.

The anæsthetic charge I employ is lighter than the cerebrospinal fluid and does not mix with it. Because of that it spreads out upon the surface of the cerebrospinal fluid like a layer of oil. The active constituent of the anæsthetic charge is percaine, besides a buffered solution of alcohol and dextrin.¹ Percaine has the advantage of producing a longer anæsthetic effect. Even with smaller doses, loss of pain sufficient for operating purposes lasts, as a rule, over 2 hours, and the return of pain does not set in earlier than 4 to 6 hours later. The duration of anæsthesia depends upon the

¹ Percaine can be secured in America in sterile ampuls from Ciba Company Inc. New York City.

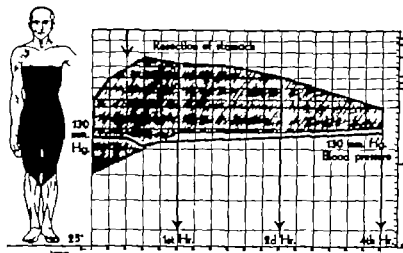


Fig. 1. Time chart and blood pressure curve in high anesthesia with a completed zone limitation in case of gastric resection.

injected was 35 cubic centimeters. This amount, however, is rarely required. As a rule 25 to 30 cubic centimeters will suffice. One can wait longer than 3 minutes to determine the exact involvement and that is particularly worth while after what is likely to be the last fill. One should not omit in any case even at the first testing to look for skin anesthesia high up in the interscapular region. It is easy to overlook this and to add more air erroneously and thus to extend the anesthesia entirely too far cranialward. Having attained the proper level we now attend to the proper depth of the anesthesia. If it is found that a pinprick still causes pain we add 0.5 or 1 cubic centimeter of percaline secured from escaping from the rubber tube by sending a little air after it. This can be visually controlled by watching the connecting glass tube. After a wait of 3 minutes the depth of anesthesia is again tested and if necessary more solution is injected. The anesthetic dose varies considerably between 2 and 8 cubic centimeters, the average being 3 cubic centimeters. It is advisable to deepen the anesthesia through the addition of 0.5 cubic centimeter to the required dose if the operation is to last more than 2 hours because the duration of anesthesia stands in a definite relation to the amount injected.

One should also take into account while giving additional air or drug that extension upward and deepening of the anesthesia will continue for at least 10 minutes. One should systematically attempt to obtain the lightest degree and the lowest level of anesthesia compatible with the carrying out of the operation. In every instance this

aim can be accomplished by one trained. In order to save time the expert can make the additional charge of air (5 cubic centimeters) plus the anesthetic charge (0.5 to 1 cubic centimeter) together so as simultaneously to affect the spread of the anesthesia upward as well as to deepen it. This maneuver is useful when it is found desirable to advance the zone of anesthesia somewhat higher or when one feels that the anesthetic effect is beginning to wear off.

As soon as the proper height and degree have been reached, the needle is removed and the patient is placed in the desired position for the operation without, however, even for an instant changing the position of his body from that of 25 degrees inclination.

b *The technique of low spinal anesthesia.* The low spinal anesthesia is carried out in a somewhat different manner. The lumbar puncture here is made as low as possible either between the fourth and the fifth or between the third and fourth lumbar vertebrae. To bring about anesthesia of the lower extremities, 15 cubic centimeters of cerebrospinal fluid are aspirated. Air is added until on aspiration the fluid level within the sac corresponds to the point of the needle. At this juncture 2 more cubic centimeters of air are added to create room for the charge. With the lateral opening of the cannula turned caudad 2 cubic centimeters of the anesthetic charge are gently expressed, 'pelvic shot'. Additional air secures complete expulsion of the charge from the rubber tube (Fig. 11). The stopcock of the small syringe is reversed and anesthesia is determined after a 3

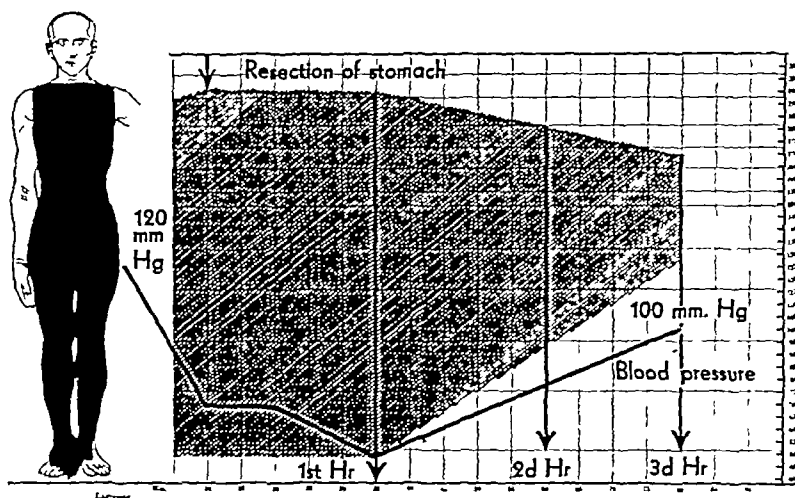


Fig 16 The time and regional chart, and blood pressure curve in high anæsthesia in a case of stomach resection. The marked fall in blood pressure suggests an error on the part of the anæsthetist, he has driven the anæsthesia above the clavicular line.

Respiratory disturbances may occur as the result of pushing the zone of anæsthesia too high cephalad. As a matter of fact, most patients do not exhibit the slightest sign of respiratory involvement even when the anæsthesia reaches the level of the jaw. By careful aspiration of air the percaïne charge can, in cases of inadvertently too high anæsthesia, be lowered back into a safe region. If the condition of the patient appears alarming and the puncture needle has been removed, a new spinal puncture should at once be done and as much of air and percaïne solution as possible removed. While this has not so far been necessary, I nevertheless mark the site of the first puncture with a readily recognizable solution and keep on hand an extra sterile needle and syringe. The knowledge of preparedness affords one a pleasant sense of security.

In high spinal anæsthesia, there occur occasionally nausea and vomiting. For this reason I give such patients a suppository of vasano one hour before the operation and when the nausea disappears an ampul of vasano subcutaneously. Ever since we began to adhere to small doses such disturbances have become exceptionally rare, provided, however, that no overdosing takes place and provided the anæsthesia has not been driven too high.

Complicating headaches were exceptional and when they did occur were not severe. Disturbances of ocular muscles or similar late disturbances have not been observed.

The new method of inducing spinal anæsthesia when correctly carried out appears to be as safe as any method can be, local anæsthesia alone being a rival in this respect. For this reason I use this method of inducing spinal anæsthesia systematically in all cases in which it is necessary to operate below the xiphoid process and in which local anæsthesia is applicable, and especially in cases in which general narcosis would endanger life, for instance, patients with arteriosclerosis, anæmia, diabetes, jaundice, nephritis, ileus, peritonitis, cachexia, shock, etc., in other words, precisely in the cases in which the older methods of lumbar anæsthesia and the use of spinocaine were contra-indicated.

ANÆSTHESIA OF THE ABDOMINAL CAVITY

With the new method, the anæsthesia can be extended high enough and made sufficiently deep to enable one to operate painlessly upon the thoracic cavity, the brachial plexus, and even upon the neck. I wish however, to warn against unnecessarily carrying the anæsthesia too far, and never deliberately to go above the intermammary line. I take advantage of the fact that the depth of anæsthesia can likewise be regulated at will, and keep it deliberately at its lowest limit much as we like to do in inhalation narcosis. Therefore, I do not regard it as a failure when the patient complains of tenderness in the upper end of a high abdominal incision, to the contrary I welcome it. By means of high pressure local

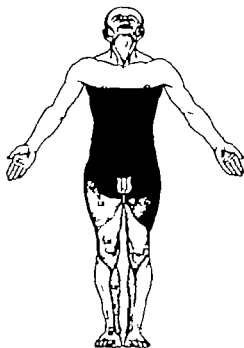


Fig. 5. The depth of the color indicates the duration of the anesthesia.

concentration of the dose. One gets along with very small doses of percaïne because the latter works its effect in a very limited portion of the dural sac and does not mix with the rest of the cerebrospinal fluid. I employ from 2 to 6 cubic centimeters of one-eighth per cent percaïne solution, in other words from 2.5 to 7.5 milligrams of percaïne. As a rule 2.5 to 3 cubic centimeters of this solution are sufficient. With these minimal doses general toxic manifestations are excluded.

The upper cranial limit of the zone of anesthesia can be controlled with great accuracy in high spinal anesthesia. I have deliberately placed it as high as the neck and was able, for example, to operate painlessly in 12 cases of mammary carcinoma with dissection of the axilla. I consider it now as too high, submitting the patient unnecessarily to the danger of respiratory paralysis. I therefore, deliberately place the upper limit of anesthesia not higher than the intermamillary line.

The cranial limit in high anesthesia to begin with is purposely placed rather lower and is only gradually and under the control of cutaneous testing extended upward. In this way the danger of driving the solution too far cranialward in an

abnormally small dural sac with resulting respiratory accidents is avoided.

The lower (caudal) limit in abdominal anesthesia is found in many instances to be in the region of the knees. From here it rises gradually to the symphysis (Fig. 13). Often the area of anesthesia also involves the calf or the entire limb (Fig. 14). The involvement of the distal roots which takes place here contrary to our theoretical considerations, and in spite of preliminary filling with air, suggests that there is some tracking through of the percaïne solution with the resulting temporary paralytic effect and that the amount of air introduced, in view of the unknown capacity of the dural sac, was too small to begin with to send the charge cranialward from the twelfth dorsal vertebra away from the area of nerves supplying the lower extremities. However sensation in these cases returns after a relatively short time following the secondary correction of upward placement of the charge as controlled by cutaneous tests (Fig. 14). At the conclusion of the laparotomy the legs are once more sensitive while the abdominal anesthesia persists for a longer time. The frequent involvement of the extremities in high spinal anesthesia does not preclude the establishment after some time of a strictly limited field of anesthesia, and, therefore, should be regarded as a *temporary phase of cone anesthesia*. The duration of anesthesia is represented in Figure 15 by the depth of the color.

When in high spinal anesthesia the extremities become more or less involved it appears that the paralysis does not affect the nerves of the blood vessels, at any rate, not completely. The much dreaded blood pressure lowering associated with the older methods is only rarely observed in our procedure (Figs. 13 and 14). A considerable fall of the blood pressure is almost always the result of a technical error due either to the spread of anesthesia up to the neck (Fig. 16) or to too big a dose of percaïne.

Another advantage not to be underestimated is to be seen in the elevated position of the pelvis which can be at any time increased still further. Cerebral anemia is thus mechanically combated. The steeper and the longer this elevated position of the pelvis, the more advantageous becomes an otherwise difficult and unpleasant position. The position of the patient is carefully accomplished by degrees and after minutes of waiting. Elevation of pelvis is convenient for most abdominal operations and it is not contra indicated in operations upon the stomach or liver. The complete relaxation of abdominal walls makes all the viscera readily accessible.

3 Failure to maintain the patient in the proper inclination of not less than 25 degrees or temporary interruption of position. Disturbing patient will dislodge the air bubble from its caudal position and with it will carry along the anæsthetic solution cranialward.

4 Improper handling of stopcocks of the double syringe during aspiration of the cerebrospinal fluid, during its emptying, or at the time of aspiration of air into the large barrel at the time of injection of air or of the anæsthetic solution into the dural sac, or at the time of its aspiration.

5 Erroneous estimate of air or of the anæsthetic solution to be injected or carelessness in permitting the escape of it from the dural sac.

6 Failure to have the liquor level correspond to the point of the needle at the time of the injection of the anæsthetic charge.

7 Failure to turn the lateral opening of the puncture needle caudalward while injecting air, or not to turn it cranialward while injecting the anæsthetic for high spinal anæsthesia, or again to turn it caudalward for low anæsthesia.

8 Failure to place the "shot" with the customary pressure.

9 Failure to inject air or failure to inject enough of it to complete the expulsion of the anæsthetic solution from the rubber tube.

10 Failure to shut off the air barrel during the waiting interval by leaving the stopcock of the small syringe open, thus permitting the passage of air or of the anæsthetic solution back from the dural sac into the air syringe.

11 Failure correctly to establish the area and the depth of skin anæsthesia, leading to insufficient or to excessive air filling or removal, or to insufficient or excessive injection of additional doses of anæsthesia.

12 Failure to wait full 3 minutes before resorting to additional filling resulting in an overdose. This is particularly likely to occur when the anæsthetist late in starting is being hurried by the surgeon. The induction of anæsthesia should begin about half an hour before the operation. A

longer period deepens the anæsthesia but it does no harm because the anæsthetic effect lasts a considerable time.

SUMMARY

The essentially new in the method described may be summed up as follows:

1 The anæsthetic solution is no longer injected directly into the cerebrospinal fluid, leaving to chance the question of its mixing and diffusing in the fluid, but on the contrary is injected in the form of a solution which is not miscible with the cerebrospinal fluid. Furthermore, the anæsthetic charge is placed in a selected segment of the dural sac and is retained there. This is accomplished by filling the caudal portion of the sac with air, the anæsthetic solution separating out in a layer because it is lighter than the cerebrospinal fluid. The localization of the anæsthesia is determined on the basis of skin sensibility by adding or diminishing the amount of air.

2 The patient is no longer given a theoretically calculated dose. In each instance the dose is carefully and sparingly graded in accordance with the effectiveness and the resulting spread of the injected solution.

3 The individual dosage and the limiting of the anæsthetic charge to a small area permit of extraordinary reduction in the size of the dose, markedly diminishing the known and the unexpected accidents of former methods.

4 The anæsthetist is no longer a bungling helper whose task is summed up in the injection of a definite dose of an anæsthetic into the spinal canal. He is now called upon to bring into play in each instance, as in inhalation narcosis, individual skill in localizing and grading the anæsthetic charge, basing his decisions beforehand on physiological considerations. Unsatisfactory results or failures are no longer ascribed to bad luck, but are charged up to the anæsthetist. For this reason, the new methods call for understanding, technical mastery, faultless necessary instruments, and affectionate devotion.

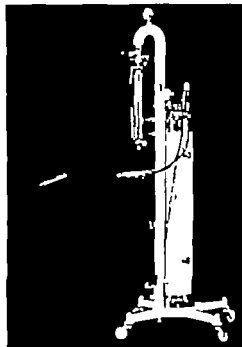


Fig. 17. High pressure local anesthesia automaton. It ejects the anesthetic fluid under the pressure of 3.5 atmospheres (Atm).

anesthesia these sensations are made to vanish in a few minutes. For I am more concerned with the preservation of the patient's strength than with the principle of a rigid and theoretical adherence to one method. Those who prefer a complete anesthesia can obtain it though without difficulty by increasing the dose.

In operations within the upper abdomen, particularly in operations upon the stomach and the biliary tracts, we enter the domain which is controlled in addition to the spinal nerves, by the sympathetic and the vagus, and it is the influence of these nerves which renders unpleasant the pull upon the tissues within the upper abdomen. These sensations likewise can be eliminated by deepening the spinal anesthesia or by advancing it further upward. All forms of anesthesia, however including inhalation narcotics, become damaging and dangerous the moment they pass beyond the limit of initial tolerance (cadaver anesthetics!) I, therefore, advise against pushing this new method to the point which would enable one to exert traction upon the tissues in the upper abdomen without pain. One should abandon this idea but systematically and without waiting for mani-

festations of pain on the part of the patient, should seek to anesthetize the sympathetic and the vagus in some different manner. This, in fact, can be accomplished in from 1 to 3 minutes with the help of my high pressure local anesthesia automaton (Fig. 17). Under a pressure of 3.5 atmospheres (Atm) one-half per cent novocain solution with $\frac{1}{1000}$ percalme-suprarenin solution is injected into the tissues in which these nerves run, in the following manner. After opening of the peritoneal cavity and introducing a retractor the transverse colon is pulled up and a deposit of anesthetic fluid the size of a fist is made to rise in the retroperitoneal tissues by injecting into the root of the transverse mesocolon from below upward and in front of the vertebrae. Next, the stomach and the transverse colon are pulled down, a rent is made in the lesser omentum, the caudate lobe of the liver is exposed to view and under the direct control of the eye an anesthetic deposit the size of a fist is placed below the diaphragm to the left of and close to the vena cava (Fig. 18, see first page of article). Finally a third deposit is placed in the lesser omentum about the stomach walls close to the esophagus so as to surround the cardia. The entire maneuver consumes hardly three minutes. All tenderness vanishes instantaneously and one may at once proceed with, say a gastric resection.

The technique of high pressure local anesthesia was described by me in earlier communications.

TECHNICAL ERRORS IN THE NEW METHOD OF SPINAL ANESTHESIA

A variety of technical errors is possible for the reason that the new method of inducing spinal anesthesia is not a simple procedure consisting of a single injection of a theoretically computed dose. On the contrary as in the inhalation narcosis it is a responsible task which, on the part of the anesthetist calls for a special knowledge, experience, personal trial, and mastery of technique. The technical errors which cause failures are as follows:

1. Boiling the syringe, tube, and the needle in soda instead of in distilled water. This reduces the effect of the anesthetic.

2. Failure to maintain a water-tight apparatus, so that air or fluid may escape. This may occur for example, if the joints of the syringe or its connections have not been oiled. The entire apparatus should frequently be tested under high pressure under water to make sure that it is water-tight. When additional injection of air fails to send the charge cranialward, the apparatus should be examined for leakage.



Fig 3 The patient 16 months after operation Scar invisible.

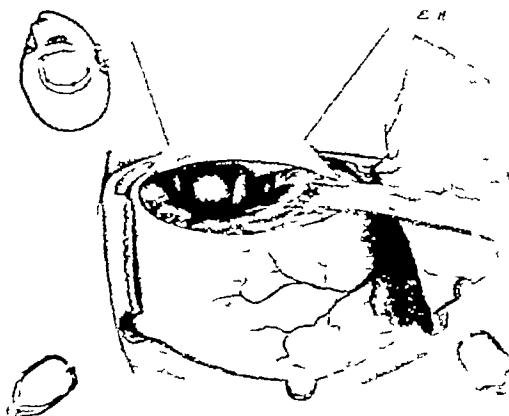


Fig 5 The approach to the sella turcica is from the side following the direction of the greater wing of the sphenoid bone. One sees presenting the tumor and its relation to the optic nerves.



Fig 4 In the 'dual' flap operation, the scalp flap is reflected forward, the bone flap will be reflected temporalward.

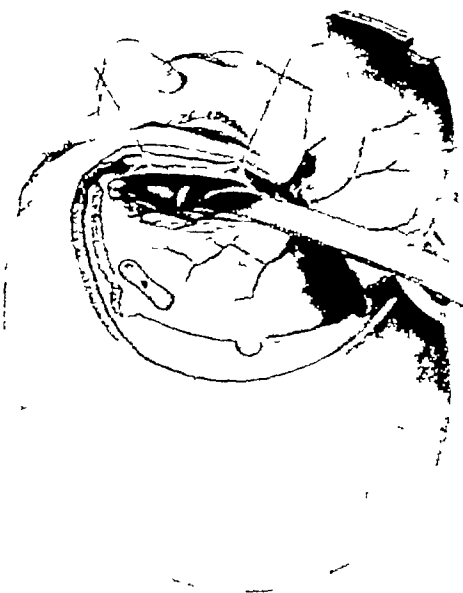


Fig 6 The flanged cannula introduced into the anterior horn of ventricle to relieve pressure. The scalp flap has been removed to make clearer structures in pituitary fossa.

FROM THE NEUROSURGICAL CLINIC UNIVERSITY HOSPITAL

RESECTION OF PITUITARY ADENOMATA

CHARLES H. FRAZIER, M.D. Sc.D. F.A.C.S. PHILADELPHIA

IN the Neurosurgical Clinic of the University Hospital, the first operation for exposure of a pituitary lesion was performed, in 1912, by the transfrontal route. Influenced by the experiences of Hirsch, in 1914, I abandoned the transfrontal route in favor of the endonasal approach. The latter approach was employed almost exclusively from 1914 to 1925 when I returned to the transfrontal method.

The endonasal method had much to be said in its favor. The mortality was low, the cosmetic result perfect, but recurrences could not be avoided. Obviously by any transphenoidal route one can but remove the intracapsular contents of the tumor. The capsule itself, at least the major portion of it and all of it in contact with the optic nerves and chiasm, remains intact. Hence, any thing approaching a radical procedure was out of the question.

Since 1925, when I resumed the transfrontal approach, I have modified the technique from time to time and, claiming no originality for any individual step, I will describe the procedure as now practiced in my clinic. That the risks of operation have been reduced measurably in re-

cent years is well known. With the technique now employed I had a series of 36 consecutive cases with but 1 death, when coincident with one of those unexplained invasions of streptococcal infections in the clinic, the thirty-seventh case died of meningitis a week after the operation.

THE OPERATION

Anesthesia. While avertin anesthesia is employed now in many of our cranial explorations, I prefer local anesthesia for pituitary operations. The operation can be conducted painlessly except when separating the capsule of the tumor from the anterior wall of the sella turcica. At this point the patient may complain acutely of pain and this may be relieved by an injection of a 2 per cent novocain solution into the capsular wall. Whether to approach from the right or the left side will depend upon the degree of optic atrophy in each disc. Usually atrophy is much farther advanced on one side than on the other. In fact, vision may be wholly lost in one eye. When there is marked asymmetry I approach from the side on which vision is the more acute. Other things being equal, I prefer the right to the left approach.

Incision. The incision begins 2 centimeters below the hair line, midfrontal, and curves gradually around to terminate above the ear (Fig. 1). For cosmetic reasons I have gradually shortened the incision. One can see in the illustration (Fig. 2) the three transitional stages. The first incision began in the temple, followed the supra-orbital ridge to the midline, thence upward into the hair line and down to the temple again, thus fashioning a rectangular flap. Later the limb along the supra-orbital ridge was abandoned and the incision began at the root of the nose and thence upward. And now the incision starts just a short distance below the hairline—most of it is concealed within the hairline and eventually is practically invisible (Fig. 3).

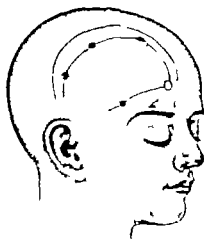


Fig. 1. The incision in the scalp does not follow the outline of the bone flap.



Fig. 2. Representing the three transitional stages from left to right.

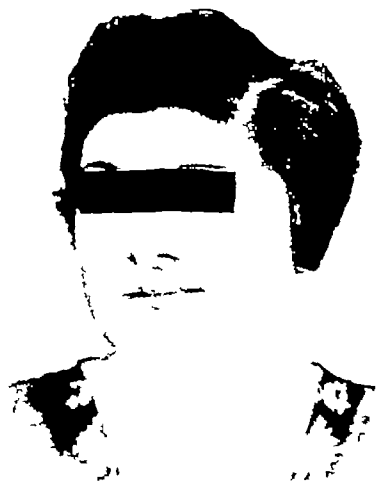


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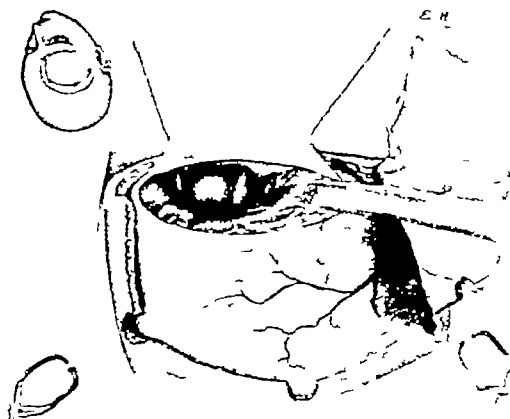


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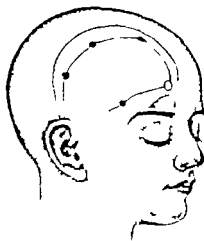


Fig. 1. The incision in the scalp does not follow the outline of the bone flap.



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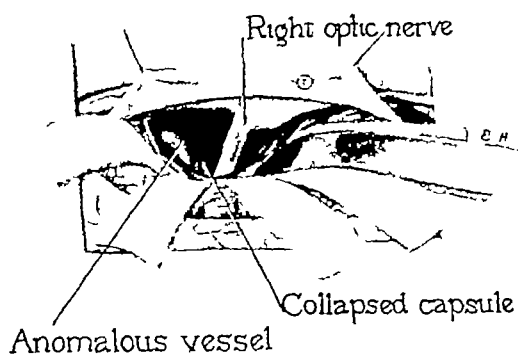


Fig 8 Capsule collapsed after evacuation of cyst

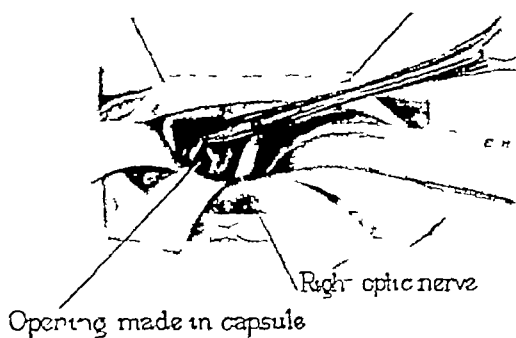
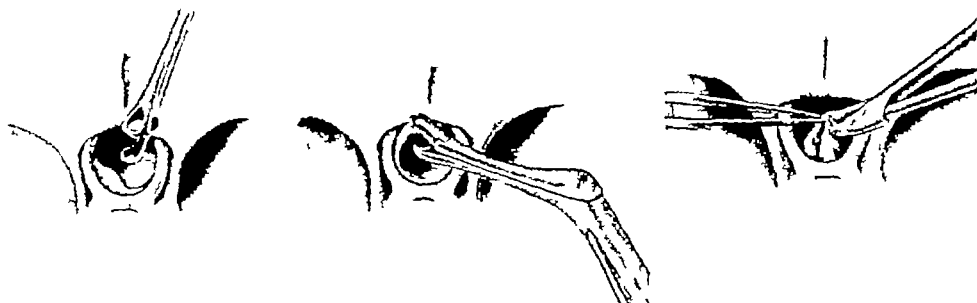


Fig 9 The initial capsular incision



Figs 11 and 12 Resection of capsule with special punches

bone, and under these circumstances I have enlarged the cranial opening with rongeur forceps downward and forward. As this area of bone is beneath the temporal muscles, the resulting defect will not be apparent and will soon be repaired.

Elevation of the frontal lobe From this point on to the closure of the wound, the room is darkened and the operative field is illuminated with our special brain retractor mounted with incandescent light. Every effort should be made to avoid harmful pressure or traction on the frontal lobe and especially the region of the tuber cinereum. Most pituitary adenomata are within the confines of the sella turcica and there is no increase in intracranial pressure. Occasionally the tumor may protrude sufficiently above the plane of the sella to impinge on the third ventricle. A ventricular block is thus established and intracranial pressure is measurably increased. One cannot explore the sella turcica safely under conditions of increased pressure. Hence one must tap the anterior horn of the ventricle before attempting to elevate the frontal lobe (Fig 6).

One should proceed cautiously, the surface of the brain should be protected with paraffin tapes as one advances slowly, centimeter by centimeter.

The cerebrospinal fluid as it wells up from the basal cistern is evacuated with the suction cannula. There always seems to me to be an excessive amount of cerebrospinal fluid present with pituitary adenomata, and the more fluid one can remove the greater the ease with which the frontal lobe may be elevated, in fact in some cases the frontal lobe recedes sufficiently by gravity to give one ample exposure for the subsequent maneuvers.

The first landmark to be seen is the olfactory nerve, right or left, as the case may be and, just

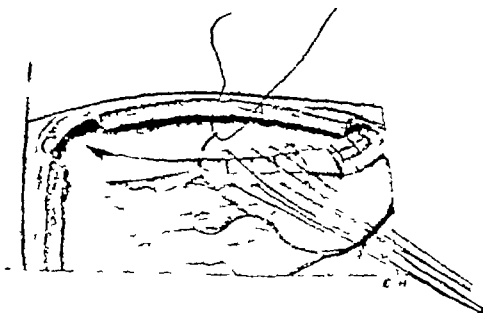


Fig 13 Closure of the dural incision with interrupted silk sutures



Fig. 7. Displacement of optic nerve varies with size of tumor. Section of tumor being removed with electrical inc.

The flap. I think it was Souttar who first called my attention to the futility of leaving the scalp attached to the underlying bone in osteoplastic resections of the skull. It was then that I adopted what might be called the "dual" flap technique as the term implies, there are two flaps, one the scalp the other the bone. In this operation the scalp flap is reflected forward (Fig. 4) and the bone flap with temporal muscle attached temporalward.

In fashioning the bone flap the anterior limb should be as near the base of the skull as possible. The nearer the base of the skull it is, the less will the frontal lobe have to be elevated. But one

must be guided by the size of the frontal sinus and in acromegalia often the sinus is of unusually large dimensions. The first perforation is made with a conical trephine, a button of bone removed to be replaced after the operation. This is the only perforation not within the hairline or beneath the temporal muscle. If this perforation were not repaired with the button of bone there would be a visible depression in the middle of the forehead. Usually four more perforations are made. The superior margin of the flap is parallel and 3 centimeters from the midline. The base of the flap corresponds to a line projected from the external canthus of the eye. If the base of the flap were lower than this the middle meningeal artery might be torn as it traverses the groove in the anterior inferior angle of the parietal bone. Thus, what often proves to be a troublesome source of hemorrhage is avoided.

The dura. My approach to the sella turcica is intradural not extradural. Once the flap is reflected an incision is made in the dura parallel with the anterior margin of the cranial defect with a slight curve forward into the perforation at either end. Sutures are introduced in the anterior margin of the dural incision for traction purposes. The exposed surface of the dura is protected with a cotton square.

The approach. We come now to what I regard as the most important feature of this operation, namely the direction by which one approaches the sella turcica. Originally choosing the shortest course from the cranial wall to the sella, I approached almost directly from before backward. In previous communications I have indicated why this course was objectionable. Today the approach to the sella turcica follows strictly the margin of the greater wing of the sphenoid bone (Fig. 5). Now in some instances, it may be that the anterior and inferior margins of the cranial opening may not permit of approach on a plane with the greater wing of the sphenoid

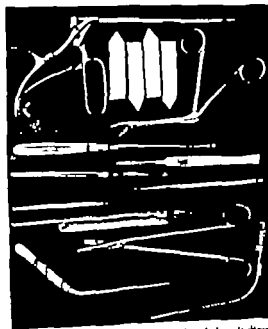


Fig. 10. Special instruments employed in pituitary operations.

and on either side and behind are the optic nerves and chiasm. One must avoid undue pressure or traction upon these at all costs. The capsule is often exceedingly vascular, and one must stop from time to time to control bleeding from its margins. In the process of resection one may use a long handled, narrow bladed pair of scissors or a special capsular punch one or both. Hæmorrhage from the margin of the capsular incision is controlled with silver clips.

Hæmostasis Perfect hæmostasis is desirable. If there be any oozing from the remnant of capsule or the floor of the sella, pledgets of cotton saturated with adrenalin solution 1:1000 may be used or occasionally a tiny muscle graft.

Now that the intracranial maneuvers are concluded I have no objection to light ether anæsthesia. The patient has been under considerable restraint and tension. He welcomes an opportunity for relaxation. Light ether anæsthesia is most welcome and under its influence the wound

is closed, first the dural incision with interrupted silk sutures (Fig 13), then the wounds in the temporal muscle and aponeurosis (Fig 14), and finally the scalp (Fig 15). In closing the dural incision, I find it an excellent plan, as a means of protecting the cortex, to place a paraffin tape beneath the suture line. After the bone flap is replaced, the button of bone is inserted in the perforation from which it was removed. A counter opening is made for a rubber tube inserted between scalp and cranium. I have found it desirable to drain this space for 24 hours.

In operations for the removal of pituitary adenomata, there is striking uniformity in the physical condition with which the operator is confronted. The location of the tumor never varies, its relation to the adjacent anatomical structures is always the same. Hence it is possible to standardize one's technique, and the operation described may be applied to every case without variation.

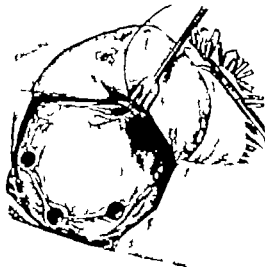


Fig. 4. Flap repositioned, bottom of base returned to position below hair line. Closure of incision in temporal muscle.

beyond, the right or left optic nerve. In this "sphenoidal wing" approach to the sella turcica the several veins which pass from the tip of the frontal lobe to the falx are not disturbed.

The intrasellar maneuvers. Once the optic nerve is seen it will soon be apparent whether we are dealing with an operable or inoperable lesion. Fortunately the large majority of pituitary adenomas are prechiasmal. (I never have been able to secure a satisfactory exposure of a retrochiasmal lesion.)

The capsule of the adenoma presents between the optic nerves and in front of the chiasm. The length, direction, and confirmation of the nerves will depend upon the size of the tumor (Fig. 7). The larger the tumor the longer the section of nerve from optic foramen to chiasm. This distance may be from 1 to 3 centimeters—the broader the tumor the greater the displacement of the nerves outward—so that their course from foramen to chiasm is not direct but describes an arc with its convexity outward. The longer the duration of the lesion the more will the nerves be flattened, ribbon-like, because of constant pressure.

Aspiration. A bluish discoloration of the capsule usually signifies a cyst. At all events routinely an exploring needle with syringe attached is introduced into the tumor and fluid, if present is aspirated. This often, though not always, depending upon the flexibility of the capsule will relieve tension (Fig. 8).

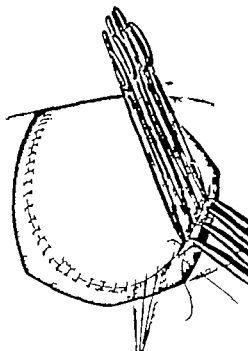


Fig. 5. Closure of scalp incision.

Capsule incision. With a sharp pointed bistoury an incision is made in the capsule (Fig. 9). With a small curette introduced through this incision the glandular contents are removed, fragment by fragment. A specimen may be sent to the laboratory for immediate diagnosis although from the naked eye appearance one can identify the tissue as that of an adenoma.

Liberation of capsule. With my dural separator the capsule is separated, with the greatest gentleness, from the optic nerves on both sides, the chiasm behind and the anterior wall of the fossa in front. (At this time and only at this time, the operation being under local anesthesia, will the patient complain of pain.) I emphasize the importance of gentleness because the optic nerves or chiasm, if damaged, cannot repair themselves and what may seem a very trivial insult may result in permanent impairment of vision.

Capsule resection. There remains now to resect that portion of the capsule which has been mobilized (Figs. 10, 11, 12). The floor of the capsule is left intact. This step of the operation, obviously the most important, requires patience and ingenuity. One is working at some distance from the surface—the cavity of the sella turcica is not large,

due to the increased blood and lymph supply which accompanies pregnancy, thus producing what really amounts to an hypertrophy of the ligaments. These changes have been found early in pregnancy. Both Driver and Muellerheim found definite movement in the pubic joint in pregnancy. Fernwald found a 3 to 5 millimeter gap in the pubic bones. He found this by placing the examining finger against the lower surface of the symphysis pubis through the anterior vaginal wall, and having an assistant make pressure against the two trochanters and then suddenly release this pressure. Engstroem placed the index finger in the vagina against the symphysis pubis, the thumb against the joint externally and, while the patient shifted the weight of her body from one foot to the other, could determine mobility in the joint. Loeschke examined the joints of four multiparæ on the autopsy table, all of whom died in the first 24 hours postpartum, and found definite mobility of the symphysis pubis in each case.

ETIOLOGY

Various hypotheses have been advanced to explain rupture of the symphysis pubis. Kehrer states that rupture is due to a pathological exaggeration of the physiological softening and distention of the entire pelvis. In support of this, both Eldridge and Eisenberger report women in whom pubic mobility became more marked through successive pregnancies. Both report that separations occurred in these pregnancies which became more marked throughout the successive pregnancies. Gusserow has reported the case of a multipara in whom all three pelvic joints became markedly relaxed each time she became pregnant. Each successive pregnancy resulted in such an increase in this mobility that, with the third and fourth pregnancies, she found herself unable to walk or stand. This relaxation disappeared immediately following delivery each time, and between pregnancies, the pelvic joints were apparently normal and symptomless. Such an explanation, however, fails to take into consideration the mechanics involved in true rupture of the symphysis pubis and this type of lesion should be regarded rather as a relaxation of the involved joints.

Lehman, Bardeleben, and others feel that rupture is due to a lack of flexibility together with a distention of the pelvis. They believe that rupture occurs only when the pubic joint does not give, i.e., when there is pathology present in the joint. Such pathology may be due to a congenital hypoplasia, caries, osteomalacia, arthritis, rickets, or contracted pelvis. This group of causes in-

cludes two of the factors which may play an important causative rôle, i.e., bony deformity or underdevelopment of the connective tissue structures. Boddaert found osteomalacia in his patient, Glenn and Colwell each found tuberculosis of the symphysis pubis, Montanelli's patient was rachitic and the patient reported by Jellinghaus had suffered from a polyarthritis for years. Holzbach reports 3 patients all of whom gave definite evidences of generalized hypoplasia of all the connective tissue structures. This was also found in 2 of the patients reported in this series.

That such a hypoplasia is not an essential factor is demonstrated by the occurrence of rupture in the patient reported by Keller. This patient did not give evidence of a generalized underdevelopment. On the contrary, she was a large muscular woman who had spent some years as a gymnasium instructor. Keller's explanation seems by far the most logical. He states that *rupture of the symphysis pubis in spontaneous labor is due to marked intensity of the uterine contractions plus marked rapidity of labor*. The validity of this explanation is completely corroborated by the analysis of this entire series.

In this series, 14 women were under 25 years of age, 31 were between the ages of 25 years and 35 years, and 12 were over 35 years. The average age of the entire group was 29 years. These figures would not seem to be significant and age, therefore, apparently, plays no rôle.

There were 18 primiparæ and 46 multiparæ. Of the latter, 13 were in their second pregnancy, 19 in their third, 6 in their fourth, and 2 in their fifth pregnancy. Six had had more than seven pregnancies. The 46 multiparæ represent 73 per cent of the total number in whom parity was mentioned. This preponderance of multiparæ in whom "marked intensity of uterine contractions and marked rapidity of labor" is much more apt to occur than among primiparæ bears out Keller's explanation as to the etiology of separation of the symphysis pubis.

The type of previous labors is apparently of no significance. Seven women had had short or easy labors, 11 had had normal labors, 4 had had long hard labors, and 3 had been delivered by forceps.

Pathological pelvis were found in 15 patients, 12 being characterized as contracted, 2 as flat rachitic, and 1 as osteomalacic, 24 were classified as being normal. This gives an incidence of 39 per cent for contracted pelvis.

There were 33 babies overweight, 22 weighing $7\frac{1}{2}$ to 10 pounds, 7 weighing over 10 pounds, and 4 being classified as very large. This gives an overweight incidence of 67 per cent. The dis-

TRAUMATIC SEPARATION OF THE SYMPHYSIS PUBIS DURING SPONTANEOUS LABOR

WITH A CLINICAL AND X-RAY STUDY OF THE NORMAL SYMPHYSIS PUBIS DURING PREGNANCY AND THE PUERPERIUM¹

RALPH A. REIS, M.D. JOSEPH L. BAER, M.D. ROBERT A. ARENS, M.D. AND ELLEN STEWART, M.D.,
CHICAGO

From the Departments of Obstetrics and X-Ray, Michael Reese Hospital

RUPTURE of the symphysis pubis during spontaneous labor and associated with clinical symptoms is rare. This occurrence, observed in 5 patients during a period of 5 years, led to an investigation of the entire subject.

Search of the world's literature yielded a total of only 62 instances of rupture of the symphysis pubis following spontaneous labor. Seventeen of these were reported by Kehler in 1915. He listed 101 ruptures of the symphysis pubis, the remaining 84 having followed forceps or breech extraction. This approximate ratio of one rupture following spontaneous labor to five following operative deliveries no longer exists since high forceps delivery has been largely replaced by cesarean section. Twenty additional case reports of rupture of the symphysis pubis following spontaneous labor were found antedating 1915, and an additional 25 from 1915 to date.

This total of 67 instances of rupture of the symphysis pubis with clinical symptoms following spontaneous labor—including the 5 reported here—range in frequency from 1 in 5,000 deliveries to 1 in 30,000. The 5 cases reported here occurred among the last 25,000 deliveries at the Michael Reese Hospital from 1912 to 1931. Nemec reports an incidence of 1 in 6,072 von Ferwald 1 in 10,000 Schauta 3 in 30,000 Seuer 3 in 64,000 and Kayser found only 3 instances in 64,000 consecutive deliveries in the Schauta and Chrobak clinics.

In an X-ray study of the symphysis pubis in 54 consecutive patients during pregnancy labor and the puerperium Brehm and Weirank reported the finding of severe separation with symptoms (a separation of more than 0.9 centimeter) in 26 per cent of the series. They further report a slight separation without symptoms in 27 per cent (0.5 to 0.9 centimeter). Only 47 per cent of their series showed no separation. They concluded that separation occurs more frequently than formerly supposed, that separations of less than 1 centimeter will not produce symptoms and that separations of more than 1 centimeter will produce the symptoms typical of traumatic separation. A frequency of 26 per cent of separation of the

symphysis pubis with symptoms and corroborative X-ray evidence is quite at variance with this or any other article in the literature. Moreover X-ray findings are useless as a diagnostic aid in this type of injury unless the rupture produces a gross separation.

It is well known that injury to the ligaments of the symphysis pubis can and do occur without the production of any clinical symptoms. Gmelin found a 1.5 centimeter gap while doing a cesarean section, Ahlfeld found a marked separation in a patient who died in labor and Zolund and Loeschke found marked separations of the symphysis pubis repeatedly at the autopsy table.

ANATOMY OF THE SYMPHYSIS PUBIS

Cunningham describes the symphysis pubis as being an amphiarthrosis. The two pubic bones are covered with hyaline cartilage with interposed fibrocartilage in the interior of which there is a vertical anteroposterior cleft. This cavity appears at about the tenth year and results from the breaking down of the interpubic lamina, there being no synovial stratum. The joint is reinforced by four ligaments, the superior and posterior ones being very weak and consisting of scattered fibers passing between the two bones. The anterior pubic ligament is thick and strong, the fibers are oblique and form an interlacing decussation. The arcuate pubic ligament occupies the arch of the pubis, is of considerable strength and gives roundness to the pubic arch. It is quite thick, is attached anteriorly and laterally to the bones, but is free in its inferior border.

ALTERATIONS OF THE SYMPHYSIS PUBIS IN PREGNANCY

Pregnancy produces definite changes in the ligaments of the symphysis pubis as well as in those which reinforce the sacro-iliac synchondroses. This has been repeatedly confirmed experimentally and by autopsy findings. From the first mention of these changes by Hippocrates to the present time, innumerable writers have found an increased mobility in the joints of the pelvic girdle

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Hæmorrhage into the involved area is usual and results in the accompanying œdema. This extravasation of blood fills the cavities produced by the tearing and separating of the fibers of the ligaments. Such a hæmorrhage may be large or even fatal. Holzbach reports such a fatality in the patient with the complete separation just described. A hæmatoma developed immediately after delivery which increased in size and dissected its way upward not only into the *cavum Retzii* but also along the anterior belly wall. Continuing hæmorrhage resulted in death 3 hours after delivery.

Infection of the involved area occurs usually when there is a communication into the vagina through lacerations. This may result in abscess formation and such a complication adds markedly to the gravity of the injury and may terminate fatally. Glenn and Colwell each report such a fatality. Abscess formation was reported 7 times in this series (Glenn, Colwell, Hartwig, Puech, Mayer, Benthin, Naujoks). In a series of 98 instances of separation of the symphysis pubis following operative deliveries, Rudaux reported abscess formation 23 times.

Unrecognizable trauma undoubtedly occurs frequently. Delestre, Glenn and Koestlein reported the finding of pubic separation at the autopsy table. Loeschke in 5 autopsies done on primiparæ all of whom died within 24 hours after delivery, found hæmorrhage into the symphysis pubis three times with tearing of the ligaments but no separation. The cavities produced by the tearing of the ligaments were filled in each instance by a serosanguineous fluid.

Autopsy studies on the normal symphysis pubis reported by Zulauf, Cruveilhier, and Loeschke indicate that the gap is greater in multiparæ than in primiparæ. The latter author states that these increased gaps are the direct result of acute birth traumata and that they are constant findings in the multipara. He found no gap present in males or in multiparæ. The series of X-ray observations reported here does not bear this out. Many observations on women made before and after spontaneous delivery in both primiparæ and multiparæ showed no appreciable differences in the size of the gap.

ROENTGEN STUDIES

The inadequacy of the X-ray in the evaluation and diagnosis of separation of the symphysis pubis in our own series led to a comprehensive X-ray study of this joint. One hundred and fifty patients were examined roentgenologically. In order to determine a normal standard, a preliminary study was made which included 20

males, 30 non-pregnant females, and 20 pregnant females. The ages ranged from 17 to 43 years. Sixteen per cent of the females were multiparæ. The pregnant women were all from the prenatal clinic of the Michael Reese Hospital. No individual was used for this study who gave a history of injury of either the pubic joint or the pelvis.

A second series, aimed at the X-ray determination and time of occurrence in pregnancy of the known physiological changes in the joint, included 80 pregnant women who were followed roentgenologically from the second or third month of pregnancy up to the time of delivery and again 10 days postpartum. Films were taken in three positions and retaken at 6 to 8 week intervals.

Position. Three positions for projecting the symphysis pubis were used in this study. (1) dorsal position, with the subject on the back. Figure 4. (2) ventral position, with the subject on the abdomen, Figure 5, (3) sitting position, with the subject in a semi-sitting position, with the back at an angle of 45 degrees and the buttocks pressed firmly against an inclined support, Figure 6, in order to place the plane of the pelvic inlet parallel to the film.

The symmetry in each instance was obtained by proper position and was maintained, together with a fixation of the lower extremities, by means of sandbags. The positions varied in the amount of discomfort to the patient in direct relationship to the month of pregnancy, the greatest discomfort always being found in position 2 and just before term. Position 3, the semi-sitting position, was comfortable at every stage of pregnancy and therefore most agreeable to all patients.

It was attempted in the preliminary work to project the symphysis pubis with patient in the upright or standing posture. This position was found to be impractical because of the progressive difficulty of projecting the symphysis pubis due to the protruding abdomen of late pregnancy. No distortion of the symphysis pubis could be found when the body weight was carried on either the right or the left leg. Traction maintained on either leg with patient in the semi-sitting posture also revealed no distortion of the joint, neither was there distortion when traction was maintained on one leg while a direct upward push was maintained on the other leg.

TECHNIQUE

All of the roentgenograms were taken on a Bucky grid. Eight by 10 films were used throughout. The symphysis was localized in each instance with a dental cone 7 centimeters in diameter. A

proportion due to a contracted pelvis may be identical with the disproportion produced by an oversized fetus. Here is the background for the violent or fulminating type of uterine contractions which is one of the causative factors in the production of separation of the symphysis pubis.

Labor was characterized as short in 6 instances. The length of labor was given as less than 1 hour in 6, 1 to 4 hours in 8, 4 to 12 hours in 24, and over 12 hours in 14. In other words, in 20 out of 38 (53 per cent) labor was unusually short.

In 5 instances delivery occurred precipitately after a particularly violent pain, 16 labors were classified as fulminating, 7 as easy and 9 as hard, 21 out of the 37 reporting on the type of labor. An incidence of 57 per cent, were therefore described as having "marked intensity of uterine contractions."

MECHANICS

The force necessary to tear the pubic ligaments and permit rupture of the fibrocartilaginous symphysis pubis has been determined experimentally. Poulett, in 1864, used 7 female pelvis and found that it required between 170 to 200 kilograms of direct pull to rupture the symphysis pubis. Thirty years later Fessler repeated these experiments and corroborated the findings. In addition he took a block of wood fashioned it so that it would exactly fill a female pelvis, and then soaked the pelvis and wood in water. The expanding wood exerted enough pressure to rupture the symphysis. Obviously the mechanical problem involved in separation of the symphysis pubis is duplicated by the expansion test discussed by Fessler rather than by the direct pulling asunder employed by Poulett.

The force that causes rupture is a wedge effect produced by the violent thrust of the fetal head through the superior strait under the combined power of the uterine and voluntary musculature. This must be true since the maximum contractile power of the uterus is something under 25 kilograms and the estimated additional power of the voluntary musculature is another 25 kilograms (Schatz). This total maximum of 50 kilograms is approximately one-quarter of the force necessary to rupture the symphysis pubis, when applied by a direct pull.

The question of involvement of the sacro-iliac joints was tested by Wishner and Mayer. They took a female pelvis, cut through the symphysis, and pried the pubic bones 4 centimeters apart. This resulted in the anterior sacro-iliac ligaments tearing and giving away so that the right joint gaped 1 centimeter and the left one 0.5 centimeter. It should be noted that in this work, damage to

the sacro-iliac joints required the production of a 4 centimeter gap between the pubic bones, a lesion which practically never happens in spontaneous labor although it is conceivable after operative delivery. Opinions as to involvement of the sacro-iliac joints differ diametrically. Ahlfeld and Wishner and Mayer state that they must be involved in true rupture of the symphysis pubis while Kayser, Muellerheim, Zweifel, v. Ferswald, and Engstrom state that such involvement of the sacro-iliac joints is not necessary.

When the sacro-iliac synchondroses are involved, the torn ligaments are those on the anterior surface of the joints, which accounts for the absence of symptoms other than tenderness referable to these joints (Wishner and Mayer). The sacro-iliac involvement seems to be more common on the right side. In analyzing the literature sacro-iliac joint involvement was mentioned 22 times. Both joints were involved in 6 patients, the right joint alone in 8 patients, and neither joint was involved in 8 patients. In only one instance was the left joint involved alone.

PATHOLOGY

The nature of the injury is primarily a rupture of the pubic ligaments, after which the fibrocartilaginous union at the symphysis is torn. The bony gap demonstrable by X-ray or by actual palpation is never a criterion of the existence or degree of the injury. Neither is it related to the presence or severity of the clinical symptoms and findings. In 4 of the 5 cases observed by us, the X-ray findings revealed no abnormal separation although all 5 women presented the typical picture of rupture of the symphysis pubis. Eisenberger reports a similar experience. His patient presented all the clinical evidences of rupture, but a widened gap between the pubic bones could neither be felt or demonstrated by X-ray examination. In a report by Mandruzzato, the diagnosis of rupture in 5 patients was based essentially on X-ray findings. As there were no typical symptoms and all of the patients were discharged as cured in a comparatively very short time, they were regarded as unproved and were therefore not included in this report.

There is rarely a complete separation of the joint, a bridge of fibrocartilage nearly always remaining. The separation may however be complete. Holzbach reports such a complete separation found at postmortem in a patient who died shortly after delivery. In this patient all of the cartilage had been completely torn and there was no connection present between the pubic bones.

IN LITERATURE AND AUTHORS' FIVE ADDITIONAL CASES

Initial Symptoms	Findings	Sacro-iliac	Duration	Recovery	Subsequent Labors
Stood up fell unconscious from pain	Pain immobility backache	Both	Short	Rapid	
Pain	Right pubis above and in front of left one				
Sudden, severe pain and descent of head-cracking sound	1 finger gap				
			4 wks.	Prompt	
			5 wks	Prompt	
Sudden crack	Pelvis larger				
Pain	Typical		3 wks	Good	
Pain on standing, sitting walking and turning	1 finger gap			Good	
Pain—could not walk last 3 mo	1 finger gap—bones movable	Both			
	1 6 cm gap	Right		Died of sepsis—27 days	
			2 wks.	Good	
			4 wks	Well	
			4 wks	Well	
Pain—could not walk. Felt as if pried apart	1 finger gap—2 finger gap while head was in pelvis		Short	Complete	
Pain—sudden as head went through	Left pubis 2 cm. higher and superimposed on right		8 wks.	Complete	Uneventful
Pain	None until autopsy		46 days	Died of sepsis	
Pain and cracking sound and sensation on walking	Marked mobility and separation	Right			
Pain	Separation—abscess 3 wks later		6 wks	Complete	
Pain	Tuberculosis found at autopsy		16 days	Died of tbc. sepsis	
Pain	Wide separation		2 mos		
Pain and grinding cracking noise heard	Pain, tenderness, waddling		1 yr		
Pain and inability to cross legs	Tenderness and definite groove	Left	7 wks.	Complete	
Severe pain and cracking noise followed by sudden delivery	Typical followed by prevesical abscess—no gap				
Pain and immobility	Tenderness 5 cm. gap, right pubis lower than left				
Immobility—snap heard on turning	Tenderness—marked mobility—no gap	Right	5 mos.	Persistent pain on walking	
	Swelling—tuberculosis, sepsis, and death		18 days	Died of tbc. sepsis	
Pain on turning and grinding could not sit or stand	Tenderness, crunching could be felt on moving, edema		6 mos	Operated upon—bones wired together	
	1 finger gap edema typical		8 wks.	Good	
Pain and grating—snapping noise heard	Mobility and tenderness				
Pain and immobility	Gap typical followed by abscess		Long abscess		
Pain and cracking heard on getting out of bed	Marked mobility—1 finger gap		14 mos	Sutured, complete recovery mobility and gap persisted	3 uneventful
None	Found at autopsy—all but posterior ligaments torn—no gap		1 wk.	Died of sepsis	
Sacral and pubic pain	3 cm. separation—X-ray positive		4 mos.	Good gap persists	
Severe pain and grinding tearing sound heard during manual removal	1 finger gap—X ray positive	Both			
Pain followed sudden turn	Tenderness edema, no rotation Left pubis $\frac{1}{4}$ in. higher, $\frac{1}{4}$ in. gap	Neither	6 wks.		

TABLE I.—CHRONOLOGICAL SUMMARY OF SIXTY TWO CASES

Author	Date	Age	Para	Previous History	Pelvis	Length of Labor	Type of Labor	Bleeding	Result
Michelson	1844		II						1 day
A. Kluck	1851	23	III			24 hr	Hard	Large	At once
J. Mammor	1852				Contracted	Long	Hard		24 stages
A. Hoffmann	1847		II		Contracted	20 hr	Hard-face presentation		
S. Hoffmann	1847		II		Contracted				
A. Beckhart	1823			Outcomeslack	Contracted		Hard		Labour
J. O'Connor	1853		II						Labour
S. Aschelt	1858	23	II		Normal	6 hr	Easy	6 lb.	20 day
S. Fuchs	1858	26	II	Born in 1st pregnancy					6th mo. pregnancy
A. Althoff	1870	30	III		Normal	26 hr			
W. Althoff	1870	24	I		Normal	1 hr			day
A. Bontarion	1870	34	VI		Short	Easy			
J. Bontarion	1870	24	I		Short	Easy			
L. Edwards	1862		II	Born in 1st pregnancy		7 hr.		10 1/2 lb.	8th mo. pregnancy
J. Manginelli	1887	24	VI	6 spontaneous labors	Normal	hr	Easy	Turkey small	24 stages of labor
W. Kautman	1888	28	VII		Contracted	20 hr		2-170 grams	
J. Kany	1890		II					Large	8th mo.
A. Hartwig	1890		III	Scarcely spontaneous		6 hr		Large	
W. Olson	1892	26	IV			6 1/2 hr	Easy	9 1/2 lb.	day
A. Ludlum	1894	27	IX	spontaneous		Short	Easy	12 1/2 lb.	day
W. Bots	1895		III						Labour
W. Dalen	1896	24	III		Contracted	Very short	Easy	Less than 7 lb	hour
A. Fench	1896	23	I		Normal	26 hr	Hard—1 sudden pain then delivery	Average	day
A. Jellingsham	1899	21	VI	All long labors polyarthritis	Normal	6 hr		4,200 grams	Labour
A. Henschbach	1900	25	I			7 hr	Long hard 24 stages		day
A. Cahrell	1904	26	IV			6 hr			
W. Schuch	1904	21	III			Long	Long hard 24 stages	10 lb.	day
A. Buchwald	1904	23	IV	All spontaneous	Normal	1 hour pain	Protrusion on stool		Immediately
W. Eastman	1906	27	II	Short labor		hr 2nd, hr	severe pain—delivery	9 lb.	At once
W. Mayne	1906		I		Normal	hr		7 1/2 lb.	20 hr.
J. Knapstrom	1907		II						8th day
J. Delastre	1908	19	I		Contracted	26 hr	Severe	4,250 grams	
J. Montanelli	1908	26	III	long spontaneous deliveries	Flat pelvis	hr 20 min.	Severe, short	4,000 grams	At once
J. Mayne	1910	26	III						24 stages
J. Knap	1910	26	VI	All short labors		8 hr			days

LITERATURE AND AUTHORS' FIVE ADDITIONAL CASES (Continued)

Initial Symptoms	Findings	Sacro- ilac	Duration	Recovery	Subsequent Labors
Pain and 'tearing apart'	Edema outward rotation 2 cm gap X-ray positive, gap normal	Both	8 wks		
Pain and tearing sensation	Tenderness edema 2 finger gap X-ray positive Abscess		12 wks	Good, X-ray showed no gap—some ossification	
Loud cracking—1 long pain—delivery	3 cm gap edema	Right		Good	
	X-ray positive				
	1 finger gap		8 wks	Good	
	1 finger gap		3 wks	Good	
Pain	Large hematoma dissecting up belly wall. 2 finger gap and cartilage all torn at autopsy	Both	3 hr	Died of dissecting hematoma	
Chills and fever 4 days then pain	Typical, 1 finger gap X-ray positive		3½ wks	Complete no gap left	
Cracking sound in 2d stage	Typical		8 wks	Good	
Sudden severe pain in 2d stage	Typical but no gap X-ray negative		6 wks	Complete	
Pain	X-ray showed 1.5 cm gap				
Pain on movement	Typical 2 cm gap found Abscess at operation X-ray positive		8 wks	Complete	
Pain	Typical			Rapid	
Pain	Tenderness edema No gap, no rotation				
Pain	Typical, X-ray positive		4 mos	Complete	
Crack heard and felt	Typical X-ray positive				
Pain	None for 1 mo., then 1 cm. gap X-ray showed 1.5 cm gap		6 mos.	Complete	
Pain and swelling	Typical gap X-ray positive		4 mos	Complete	
Pain and swelling	Edema, X-ray showed wide gap			Complete	
Pain and swelling	Edema, tenderness X-ray showed wide gap	Right	4 wks	Complete	
Pain and swelling	Edema tenderness			Complete	
Pain	Edema Feel gap X-ray shows slight separation	Neither	3 wks	Complete	
Pain	X-ray shows 3 cm. gap after 3 mos	Right	4 mos.		
Pain	Typical, 1 finger gap. X-ray positive		1 mo		
Pain	Typical, 1 finger gap. X-ray positive				
Pain	Tenderness and gap Both bones movable				
Pain	1.5 cm separation X-ray positive		3 wks	Complete, X-ray showed 1 cm. separation	
Pain especially on moving	Typical. X-ray shows no gap but absorp- tion left ramus	Neither	5 wks	Complete	2 normal
Pain especially on bedpan	Typical and mobility No gap X-ray negative	Neither	4 wks	Complete	
Pain and pain in right hip	Typical X-ray positive	Right	5 wks	Complete	
Pain	Typical, X-ray negative	Neither	3 wks	Complete	2 normal
Pain—pneumonia at same time	Typical and pneumonia then pleurisy and effusion	Neither	8 wks	Complete	

SURGERY GYNECOLOGY AND OBSTETRICS

TABLE I.—CHRONOLOGICAL SUMMARY OF SIXTY TWO CASES IN

Author	Date	Age	Para	Previous History	Pelvis	Length of Labor	Type of Labor	Born Baby	Cost
24. Katchach	1911	24	1st	long, short	Flat rachitic	20 min.	Painless	Very small	day
27. Benthon	1905	26	17	All spontaneous		hard pain	Cracking sound followed by delivery	4,640 grams	Labour
28. Anderson	1912	3	11			very rapid	Strong pains		8 hr
29. Triller	1912	26	14	Normal full term		hr	Strong pains	5 1/2 lb.	14
30. Flahbach	1905		1	Very fast	Normal	2 hr	Rapid—strong pains	6 lb	hr
41. Kitchach	1905	20	1	Very fast	Normal	8 hr	Rapid—strong pains		
Flahbach	1905	25	1				rd ribs delivered by strong pain	4,300 grams 2,000 grams	3 days
43. Polgar	1912	27	10	Normal labors	Normal	Short	every pain followed by cracking sound—head went from inlet to perineum by one pain	4,750 grams	Labour
44. Meent	1906	26	17	All 3 day labors	Con-tracted	8 hr	Hard labor	4,000 grams	Labour
48. Kuenberger	1906	29	10	Bones with 1st baby 4,000 grams		3 hr		4,000 grams	day
26. Hayman	1907	26			Normal	10 hr		3,700 grams	At once
47. Wozjals	1907	20		All easy and short	Normal	10 hr		2,700 grams	
48. Olwe	1907	26			Con-tracted	hr			day
29. Benda	1908	22	1		Normal	2 1/2 hr		2,800 grams	Labour
30. Damsch	1908	22					Short and hard—crack 1st and 2nd	2,800 grams	Labour
31. Damsch	1908	22			Contracted	8 hr		4,770 grams	day
32. Puchall	1908	20			Normal	6 1/2 hr		4,000 grams	day
33. Puchall	1908	27			Normal	1 1/2 hr		4,000 grams	day
34. Koller	1908	20	10	Normal delivery	Normal	hr		1st stage	day
42. Koller	1908	21		Gynaecology teacher				2nd stage	1st day
35. Koller	1908	27		Forceps delivery	Normal	14 hr		3rd stage	day
37. Koller	1908	27	10	Normal delivery	Normal	14 hr		4th stage	At once
38. Borden	1909	22		Normal delivery	Con-tracted	very short		5th stage	day
39. Lamm	1909	25	10	Normal delivery	Contracted			6th stage	At once
40. Lamm	1909	25	10	Normal delivery	Contracted			7th stage	At once
41. Lamm	1909	25	10	Normal delivery	Contracted			8th stage	At once
42. Lamm	1909	25	10	Normal delivery	Contracted			9th stage	At once
43. Lamm	1909	25	10	Normal delivery	Contracted			10th stage	At once
44. Lamm	1909	25	10	Normal delivery	Contracted			11th stage	At once
45. Lamm	1909	25	10	Normal delivery	Contracted			12th stage	At once
46. Lamm	1909	25	10	Normal delivery	Contracted			13th stage	At once
47. Lamm	1909	25	10	Normal delivery	Contracted			14th stage	At once
48. Lamm	1909	25	10	Normal delivery	Contracted			15th stage	At once
49. Lamm	1909	25	10	Normal delivery	Contracted			16th stage	At once
50. Lamm	1909	25	10	Normal delivery	Contracted			17th stage	At once
51. Lamm	1909	25	10	Normal delivery	Contracted			18th stage	At once
52. Lamm	1909	25	10	Normal delivery	Contracted			19th stage	At once
53. Lamm	1909	25	10	Normal delivery	Contracted			20th stage	At once
54. Lamm	1909	25	10	Normal delivery	Contracted			21st stage	At once
55. Lamm	1909	25	10	Normal delivery	Contracted			22nd stage	At once
56. Lamm	1909	25	10	Normal delivery	Contracted			23rd stage	At once
57. Lamm	1909	25	10	Normal delivery	Contracted			24th stage	At once
58. Lamm	1909	25	10	Normal delivery	Contracted			25th stage	At once
59. Lamm	1909	25	10	Normal delivery	Contracted			26th stage	At once
60. Lamm	1909	25	10	Normal delivery	Contracted			27th stage	At once
61. Lamm	1909	25	10	Normal delivery	Contracted			28th stage	At once
62. Lamm	1909	25	10	Normal delivery	Contracted			29th stage	At once
63. Lamm	1909	25	10	Normal delivery	Contracted			30th stage	At once
64. Lamm	1909	25	10	Normal delivery	Contracted			31st stage	At once
65. Lamm	1909	25	10	Normal delivery	Contracted			32nd stage	At once
66. Lamm	1909	25	10	Normal delivery	Contracted			33rd stage	At once
67. Lamm	1909	25	10	Normal delivery	Contracted			34th stage	At once
68. Lamm	1909	25	10	Normal delivery	Contracted			35th stage	At once
69. Lamm	1909	25	10	Normal delivery	Contracted			36th stage	At once
70. Lamm	1909	25	10	Normal delivery	Contracted			37th stage	At once
71. Lamm	1909	25	10	Normal delivery	Contracted			38th stage	At once
72. Lamm	1909	25	10	Normal delivery	Contracted			39th stage	At once
73. Lamm	1909	25	10	Normal delivery	Contracted			40th stage	At once
74. Lamm	1909	25	10	Normal delivery	Contracted			41st stage	At once
75. Lamm	1909	25	10	Normal delivery	Contracted			42nd stage	At once
76. Lamm	1909	25	10	Normal delivery	Contracted			43rd stage	At once
77. Lamm	1909	25	10	Normal delivery	Contracted			44th stage	At once
78. Lamm	1909	25	10	Normal delivery	Contracted			45th stage	At once
79. Lamm	1909	25	10	Normal delivery	Contracted			46th stage	At once
80. Lamm	1909	25	10	Normal delivery	Contracted			47th stage	At once
81. Lamm	1909	25	10	Normal delivery	Contracted			48th stage	At once
82. Lamm	1909	25	10	Normal delivery	Contracted			49th stage	At once
83. Lamm	1909	25	10	Normal delivery	Contracted			50th stage	At once
84. Lamm	1909	25	10	Normal delivery	Contracted			51st stage	At once
85. Lamm	1909	25	10	Normal delivery	Contracted			52nd stage	At once
86. Lamm	1909	25	10	Normal delivery	Contracted			53rd stage	At once
87. Lamm	1909	25	10	Normal delivery	Contracted			54th stage	At once
88. Lamm	1909	25	10	Normal delivery	Contracted			55th stage	At once
89. Lamm	1909	25	10	Normal delivery	Contracted			56th stage	At once
90. Lamm	1909	25	10	Normal delivery	Contracted			57th stage	At once
91. Lamm	1909	25	10	Normal delivery	Contracted			58th stage	At once
92. Lamm	1909	25	10	Normal delivery	Contracted			59th stage	At once
93. Lamm	1909	25	10	Normal delivery	Contracted			60th stage	At once



Fig 1 1, The deep narrow type of symphysis in the male, type 1, with the typical acute pubic angle 2, The shallow broad type of symphysis in the male, type 2 The pubic angle here is an obtuse angle forming the pubic arch which is found more frequently in the female 3, The deep narrow type of symphysis in the female, type 1 Contrast the broad pubic arch with the acute pubic angle in 1 4, The shallow type of symphysis in the female

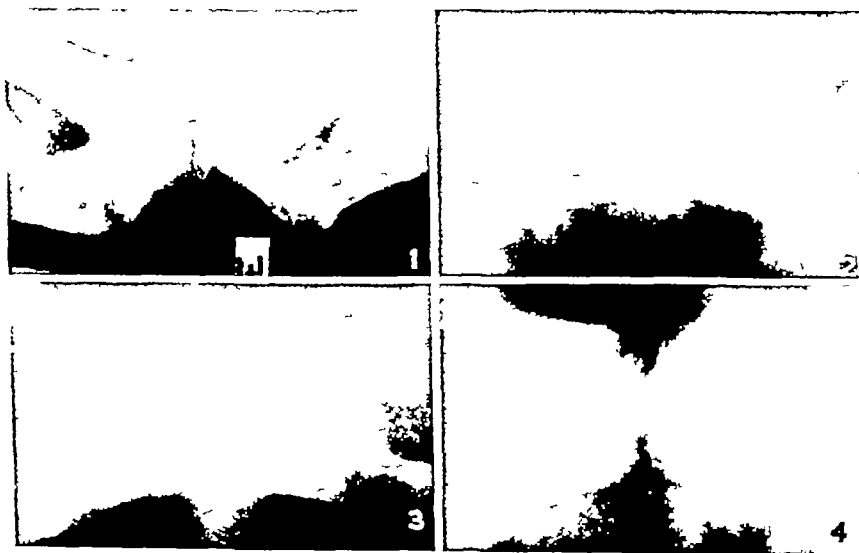


Fig 2 1, The shallow, broad type of symphysis, type 2, in the male Here the pubic bones form a broad arch rather than an acute angle 2, The deep narrow type of symphysis in the male Here this male type is associated with a very broad pubic arch 3, The broad shallow type 2, in the female Note the marked width of the pubic arch The angle formed by the pubic bones in this instance is over 135 degrees 4 The deep narrow type 1 in the female with a typical pubic arch

constant target distance of 36 inches was maintained. All other factors were also constant except time which naturally varies according to the thickness of the part and the term of pregnancy.

This standard distance of 36 inches does admit of some distortion as compared to a teleo or a meter distance. However with the technique employed this distortion is not sufficiently great to necessitate the consideration of using a larger target distance with its subsequent increase in exposure. If necessary the distortion co-efficient can be calculated and the symphyses can be measured. Therefore, it did not seem advantageous to use special measuring devices such as have been described for work of this character.

The question arose as to the effect of the repeated exposures to the roentgen ray. In no instance was any effect found in either mother or fetus that could be attributed to the use of the roentgen rays. This is in accord with the work of Stein and Arens.

RESULTS

Considered roentgenologically there are two general types of symphyses pubis. The one is the type found predominately in the males. Here the joint is long as the result of the increased height of the pubic bones. The transverse diameter in this type is usually quite short resulting in a long narrow joint (Figs. 1 and 2). The other type is most frequent in females. Here the joint is short in its vertical diameter but wider in its transverse diameter resulting in a shallow but broad joint (Figs. 1 and 3). All gradations between these two general types have been found, and it is noteworthy that many of the masculine type are found in the female and many resembling the female type are found in the male. So frequently is this true that it has been found impossible to differentiate accurately from the contour of the symphysis pubis alone. The characteristic pubic angle of the male is an acute angle while the characteristic pubic arch of the female is an obtuse angle.

The faces of the pubic bones show many variations. Some are smooth and regular while others are saw toothed or serrated. The latter are most frequently found in younger individuals of both sexes and probably represent incomplete ossification (Fig. 3). Many show areas resembling rarefaction and bone absorption and others are hook-shaped or S-shaped.

It has been impossible to find any characteristic changes in the symphysis pubis due to pregnancy. Multiparity apparently has no effect on the joint that can be demonstrated roentgenologically (Fig. 12). Nor has it been possible to demonstrate

any changes in the joint during pregnancy or the puerperium. Repeated films taken at varying intervals throughout pregnancy as well as postpartum show no changes in the symphysis pubis (Figs. 7, 8, 9, 10, 11, 12). In no instance in this series of 80 patients followed through the course of their pregnancy was any change found.

Mobility of the symphysis pubis was sought for in each examination. In no instance could it be demonstrated roentgenologically in any of the three positions. Likewise, widening of the joint due to the influence of pregnancy or labor was not demonstrable. The narrow joint of the young primipara (Fig. 10) remained unchanged throughout pregnancy, and the broad joint of a bipara likewise remained unchanged (Fig. 10). Apparently the individual characteristics of any given symphysis are ordinarily not sufficiently altered by pregnancy to be demonstrable roentgenologically. Instances undoubtedly occur in which the widening of the joint is obvious but they are uncommon. It would seem that the physiological relaxation of pregnancy is a potential widening in preparation for labor rather than an actual widening. The 98 per cent of Snelling's series of 500 cases showing "increased mobility of not more than 3 millimeters" would seem to fall within the range of normal.

The 5 instances of separation of the symphysis pubis during spontaneous labor reported here for the first time, are as follows:

CASE 1: Mrs. L. R., aged 30 years. She had measles, chicken-pox, and pneumonia in childhood. Two previous pregnancies had ended in abort, spontaneous, and eventual deliveries. The last menstrual period began on July 9, 1931, and she entered the hospital on April 23, 1932. The general physical examination was negative, there being no evidence of rickets or other constitutional diseases. Blood pressure and urine were normal. The interpubic diameter was 10 centimeters; the intercubital, 7 1/2 centimeters; right oblique, 23 centimeters; left oblique, 23 centimeters; conjugata externa, 8 1/2 centimeters; and the conjugata interna, 7 plus centimeters. The pregnancy was evidently full term and the fetal head was engaged at the onset of labor. The labor was induced by castor oil, 3 ounces, followed in 2 and a half hours by quinine sulphate, 12 grains. The first stage lasted 5 hours and the second stage 5 minutes with fulminating labor pains and rapid descent and expulsion of the head. Position was right occiput anterior. The child was large male 90 centimeters long and weighing 4,700 grams. On the third day the patient complained of severe suprapubic pain which was intensified by any movement of the legs. Examination showed some tenderness about the symphysis, marked tenderness, and some mobility of the pubic ramus. There was no outward rotation of the legs but passive motion produced severe pain over the symphysis. Median pressure exerted over both trechanters simultaneously produced an lateralization of the pain. Pulse and temperature were normal throughout the entire puerperium. Immobilization by 3 inch strips of adhesive tape produced such an lateralization of the pubic

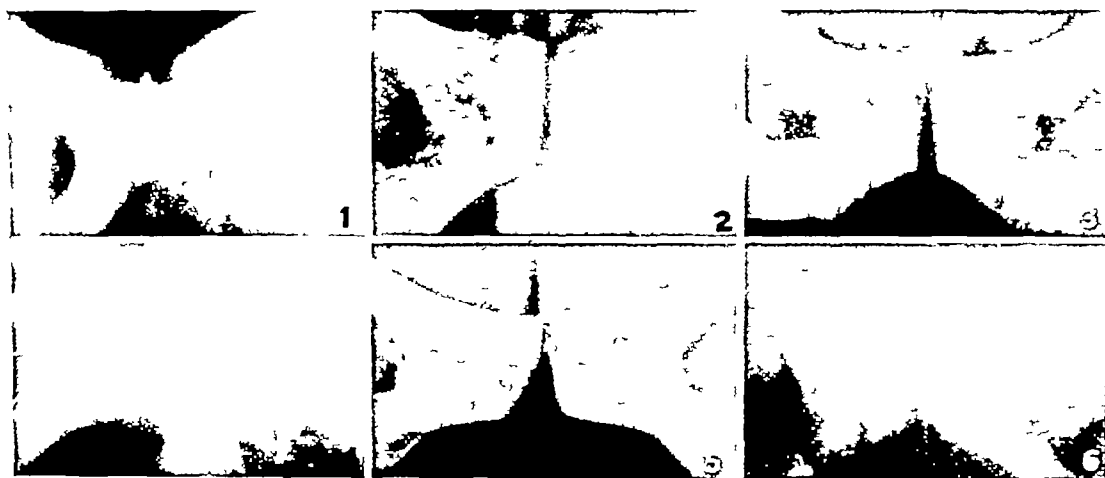


Fig 5 Ventral position Position 2 1, 2, 3 show three male symphyses taken in the ventral position. 4, 5 6 show three female symphyses taken in the ventral position

weighed 3,430 grams The fetal measurements were somewhat large, the occipitofrontal diameter being 12.5 centimeters, the biparietal, 10, occipitomenal, 15.5 centimeters The occipitofrontal circumference was 36 centimeters, the occipitomenal, 41 centimeters, and the bisacromial, 34 centimeters

On the sixth day she complained of suprapubic pain on urination which on the following day was present at all times and was intensified by movements of the legs Examination at this time showed some oedema of the vulva and symphysis but only slight tenderness As all symptoms were gone on the eleventh day the patient was permitted to get out of bed The following day she complained of severe suprapubic pain which prevented her from standing sitting, or walking, and she was put to bed again Examination at this time showed tenderness, mobility of the pubic

bones which produced a grating sensation, some oedema and marked tenderness and mobility on vaginal examination X-ray films showed no increase in width of symphysis The pelvic girdle was immobilized by circular three-inch strips of adhesive tape which extended completely around the body This immobilization produced immediate relief On the twenty-eighth day the patient was permitted to get out of bed Walking was accompanied by some pain and a waddling gait Both of these persisted for 3 months Climbing stairs and any other movements which tilted the pelvis excessively produced pain for about 4 months, after which the recovery was complete It is of interest to note that the patient had a sturdy but short frame being only 4 feet 9 inches in height Her husband had an unusually large head and frame, being 6 feet 3 inches in height and weighing 210 pounds

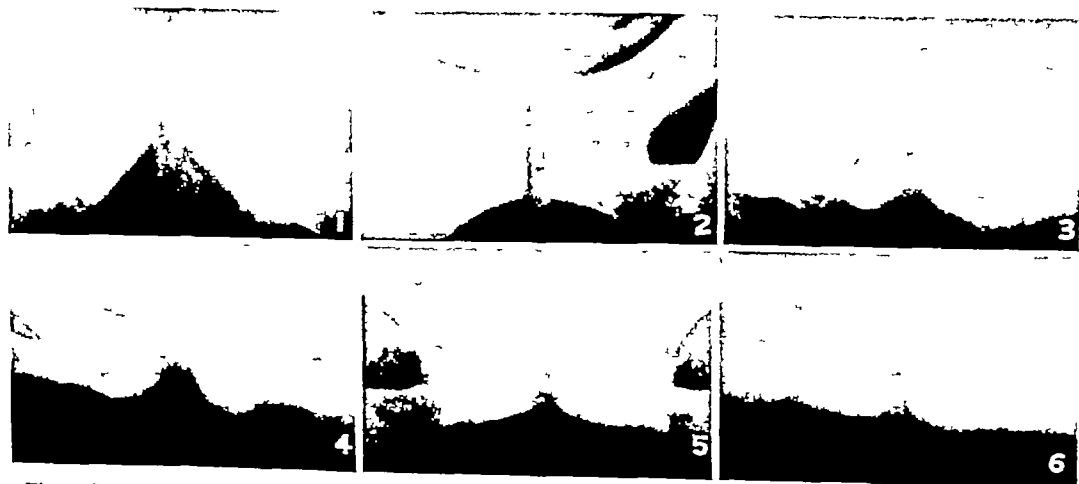


Fig 6 Semisitting position Position 3 1, 2, 3 show three male symphyses taken in the semisitting position 4, 5 6 show three female symphyses taken in the semisitting position



Fig. 3. Variations in the facies of the pubic bones: 1, Smooth type; 2, serrated type; 3, S-shaped type; 4, raveled type; 5, hook type.

pain that it was necessary to remove them. A vaginal examination at this time showed only a slight gap but definite mobility of the pubic bones. X-ray examination revealed absorption and rarefaction of the left head involving the body of the os pubis but no demonstrable increase in the width of the symphysis. Immobilization was then secured by placing sandbags against the legs from the ankles to the level of the iliac crests. The pain gradually subsided and the patient was comfortable. On the twenty-third day the sandbags were removed and the patient was able to sit in bed without experiencing any pain. On the twenty-eighth day she was permitted to get out of bed. Walking was painless but the gait was somewhat waddling. This persisted for 3 weeks. The tenderness over the symphysis lasted for 3 months. This patient has since gone through two full term, spontaneous labors which were un-

eventful and produced no symptoms referable to the symphysis.

Cure. Mrs. R. J., aged 3 years. There were no previous pregnancies or history of any constitutional diseases. The last menstrual period began March 1, 1934 and labor began on December 9, 1934. General physical examination was negative with no evidence of rickets or other constitutional diseases. The pregnancy was full term. At the head engaged. Pelvic measurements were internipple, 21; intercrural, 24; right oblique, 31; left oblique, 31; conjugata externa, 31; and conjugata interna, 20 centimeters. The first stage of labor lasted for 9 hours and 30 minutes and the second stage for 1 hour and 3 minutes. The delivery was spontaneous after second stage pains of normal intensity and frequency. Presentation was right occiput anterior. The male child was 35 centimeters in length and

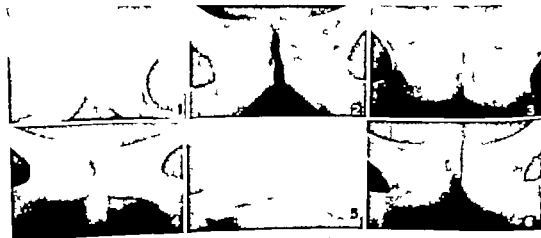


Fig. 4. Dorsal position. Position 1, 3, 5 show three male symphyses taken in the dorsal position. 2, 4, 6 show three female symphyses taken in the dorsal position.

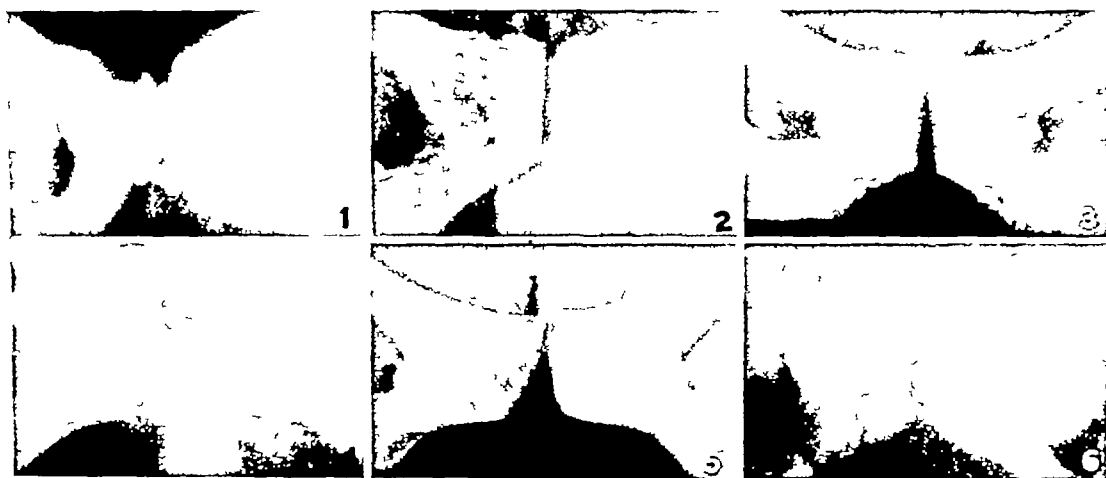


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On the sixth day she complained of suprapubic pain on urination which on the following day was present at all times and was intensified by movements of the legs. Examination at this time showed some oedema of the vulva and symphysis but only slight tenderness. As all symptoms were gone on the eleventh day the patient was permitted to get out of bed. The following day she complained of severe suprapubic pain which prevented her from standing, sitting or walking, and she was put to bed again. Examination at this time showed tenderness, mobility of the pubic

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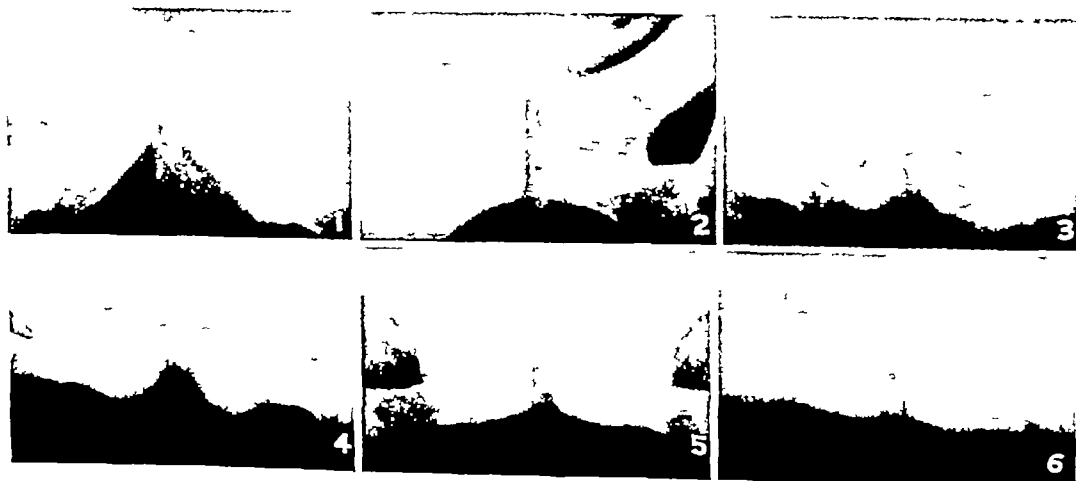


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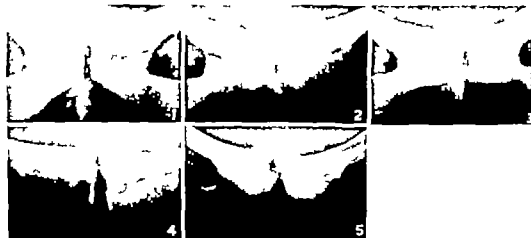


Fig. 3. Variations in the facies of the pubic bones: 1, Smooth type; 2, serrated type; 3, S-shaped type; 4, turned type; 5, hook type.

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eventful and produced no symptoms referable to the symphysis.

CASE 2. Mrs. R. J., aged 33 years. There were no previous pregnancies or history of any constitutional diseases. The last menstrual period began March 1, 1934 and labor began on December 9, 1934. General physical examination was negative with no evidence of rickets or other constitutional diseases. The pregnancy was full term, with the head engaged. Pelvic measurements were: interspinous, 22; intercrural, 24; right oblique, 18; left oblique, 18; conjugata externa, 13; and conjugata interna, 11 centimeters. The first stage of labor lasted for 9 hours and 30 minutes and the second stage for 400 and 3 minutes. The delivery was spontaneous after second stage pains of normal intensity and frequency. Presentation was right scapula anterior. The male child was 51 centimeters in length and

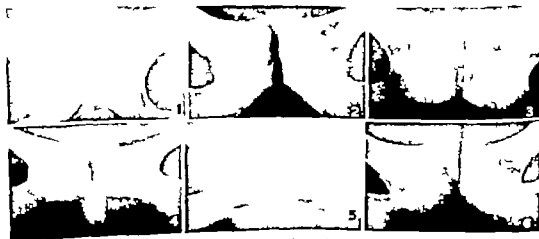


Fig. 4. Dorsal position. Positions 1, 2, 3 show three male symphyses taken in the dorsal position; 4, 5, 6 show three female symphyses taken in the dorsal position.

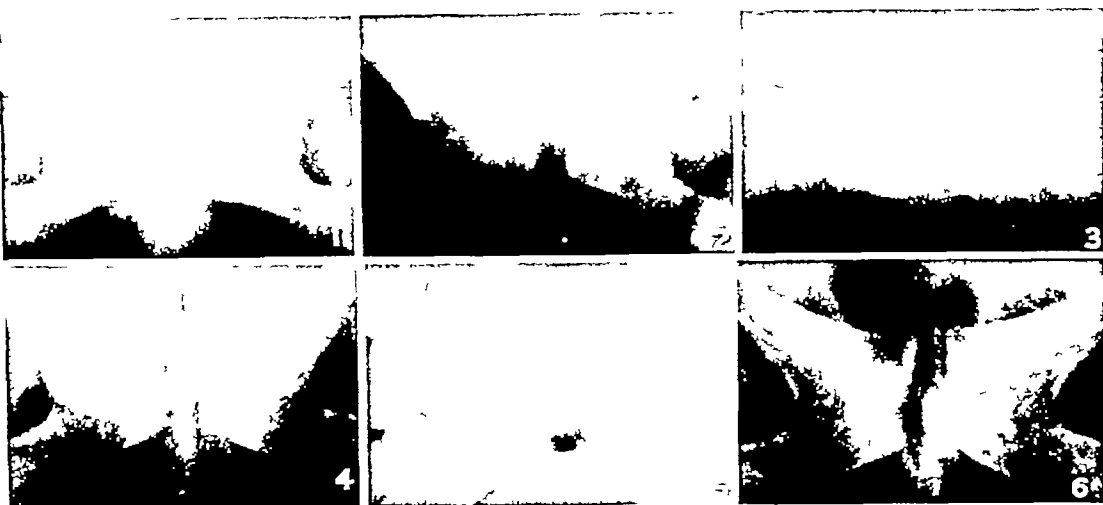


Fig 9 Symphysis in late pregnancy 1, 2, 3 show the three positions in a 23 year old n-para at 8 months 4, 5, 6 show the three positions in a 27 year old n-para at 9 months

pelvis or movements of the legs increased the pain. The pelvic girdle was immobilized by a tight binder which produced relief of symptoms. On the sixteenth day the patient was out of bed but walking was difficult and painful. The gait was unsteady and waddling in character. One week later all symptoms and findings had disappeared and the patient was apparently well.

CASE 4 Mrs. B. B., aged 27 years. She had had the usual diseases of childhood and one previous pregnancy which ended by a short labor and a forceps delivery. Last menses began October 4, 1925, and labor began on July 5, 1926. The general physical examination was negative, the blood pressure and urine normal, and the pelvic measurements were interspinous, 27 centimeters, intercrural, 30 centimeters, right oblique, 23.5 centimeters, left oblique 24 centimeters, conjugata externa, 20.5 centimeters, and

conjugata interna, 12 plus centimeters. The first stage of labor lasted 6 hours and 40 minutes and the second stage 35 minutes. The pains were at 3 minute intervals and of average intensity. One hour and 30 minutes before delivery the head was still floating. Delivery was spontaneous and the presentation was left occiput anterior. The child was a male 52 centimeters in length and 3,800 grams in weight. The puerperium was afebrile and uneventful until the eighth day when the patient complained of pain over the symphysis which was aggravated on turning or by moving her legs. Examination showed some tenderness and mobility of the joint but no definite gap could be felt. The mobility was especially marked on vaginal examination which also revealed a 1 centimeter gap. Passive motion of the legs increased the pain. Immobilization was secured by circular adhesive strips which produced relief of symptoms.

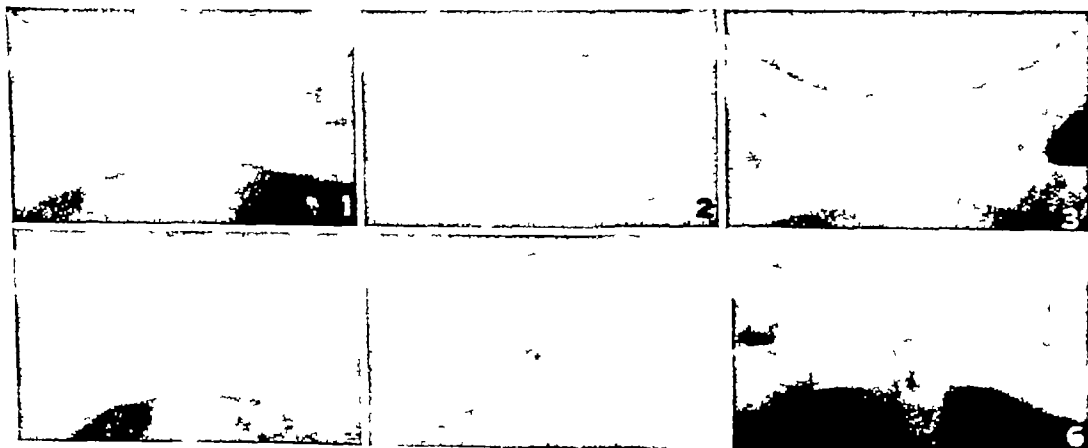


Fig 10 Symphysis postpartum The three positions postpartum 1, 2, 3 in a 17 year old n-para 4, 5, 6 in a 21 year old n-para



Fig. 7. Symphysis in early pregnancy. The three positions give practically the same contour to the symphysis. 1, 3, 5 are from a 35 years old para 1; 2, 4, 6 are from a 19 years old para 1.

CASE 3. Mrs. M. W. aged 33 years, with history of two previous spontaneous and uneventful labors. The last menses began on January 28, 1948, and labor began on November 14. General examination showed no abnormalities or evidences of constitutional disease. Pelvic measurements showed an interspinous diameter of 26 centimeters, an intercrural of 20 centimeters, conjugata externa of 20 centimeters, and conjugata interna of 18 centimeters. The pregnancy was apparently full term and the presentation was cephalic with the head at the level of the spine when labor began. The first stage of labor lasted 2 hours and 40 minutes, the pains, however, being very slight, ineffective, and 10 minute intervals throughout. The membranes were then ruptured artificially and

the patient was given 10 min. of pituitrin intramuscularly. The pains then became stronger and more frequent and the baby was born 45 minutes later. The position was right occiput anterior. The child was a male, 50 centimeters in length and weighing 4,170 grams. The perineum was atonic but on the eighth day the lochia became foul. On the seventh day the patient complained of pain over the pubis, the right hip, and the lower back. There was moderate tenderness of the labia and the pubic region, marked tenderness over the symphysis and the right sacro-spinous synchondrosis, but no mobility of the pubic bones. A definite gap could be felt which was about 1 centimeter in width. Median pressure exerted over both trochanters at the same time produced relief of the pain. Tilting the



Fig. 8. Symphysis in mid pregnancy. 1, 3, 5 are from a 27 years old para 1; 2, 4, 6 are from a 34 years old para 1. 6 is markedly narrowed due to the fact that the pelvic inclination in this patient was marked. Being more than normal, the rays caught the pubic bones at exactly right angles to their superior surface. The shadow, therefore, appears quite narrow. In most instances the pelvic inclination was such that some of the superior-inferior length of the pubic bones was projected on the film.

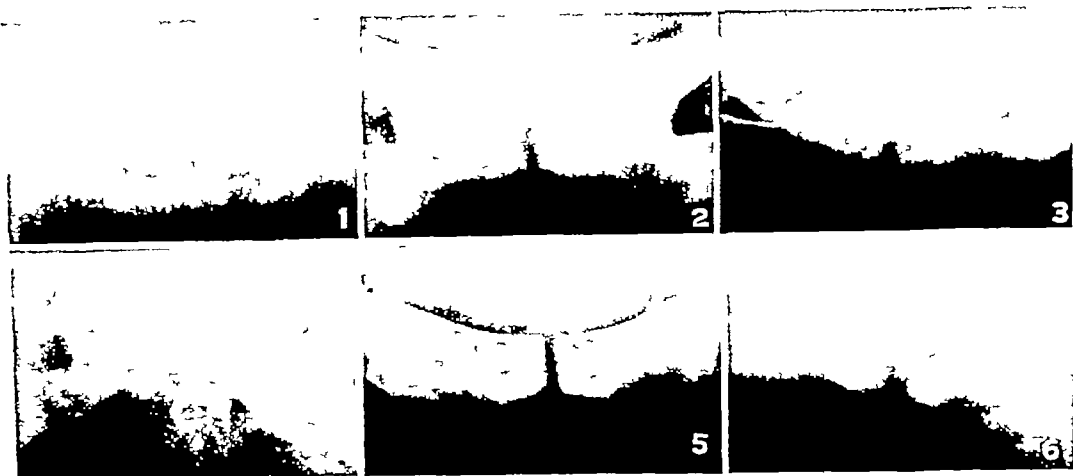


Fig 12 The symphysis in multiparae 1, i-para, 2, ii-para, 3, iii para, 4, v-para, 5, vii para, 6, ix-para

stant dull ache. Any movement of the lower extremities or of the pelvic girdle intensifies this pain until it becomes sharp and lancinating. Turning in bed, use of the bed-pan, sneezing or coughing all increase the severity of the pain. Sitting is usually quite painful and uncomfortable because of the pressure on the lacerated fibrocartilage of the joint. Standing is equally distressing because of the added factor of weight bearing.

Walking produces pain and marked discomfort due to the increased mobility of the joint together with the fact that the two ends of the pubic bones rub against each other. This instability of the pubic arch produces a characteristic gait or "waddle" which persists for some time after the joint has apparently healed. Any movements which tilt the pelvic girdle, such as standing on one leg or the use of stairs, increases the pain in the joint. The typical waddling gait found in this condition is exactly the same as that found after symphysiotomy or pubiotomy. The senior author (J. L. B.) observed and studied the after-effects of these two operations in approximately 50 patients in the Schauta clinic in Vienna in 1907, and he found that the resemblance of the postoperative gait with that produced by traumatic separation is most striking. Equally striking is the similarity of the complications and sequelæ following these two types of lesions.

The severity of the pain together with the fear of intensification on movement results in a pseudoparalysis of the lower extremities which much be differentiated from true paraplegia. Pain is present in the sacro-iliac joints only when these latter are involved. This sacro-iliac pain is

never referred to the thighs and does not produce spasm of the hamstring muscles. The tenderness is localized to the joint itself.

PHYSICAL FINDINGS

The physical findings are so typical that "after the first case has been studied, others were diagnosed without roentgenogram" (Wishner and Mayer). Marked swelling and œdema are present about the joint. Tenderness is practically always present and in some instances a definite gap or groove can be felt between the pubic bones. This tenderness is always present on vaginal examination, at which time the gap can be felt, if present. Combined vaginal and external examination often elicits mobility of one or both pubic bones and occasionally such mobility produces a grating sensation. In some instances the pubic bones are no longer in alignment and in addition are found to be at different levels.

In addition to the pseudoparalysis, the lower extremities are usually found in marked eversion and abduction with some external rotation. This latter finding is not, however, as constant as are the eversion and abduction.

All of the typical findings including œdema, swelling, tenderness, disturbed gait and pain following bilateral pressure on the trochanters were recorded in 28 of the case reports. A gap or groove was felt in 34 but was definitely absent in 12. Movable pubic rami were recorded in 17 and in 5 these were found at different levels. External rotation of the lower extremities was absent in 9. In the 30 reports which did not list all of the typical symptoms, tenderness was recorded in 12, œdema and swelling in 11. In 2 patients the

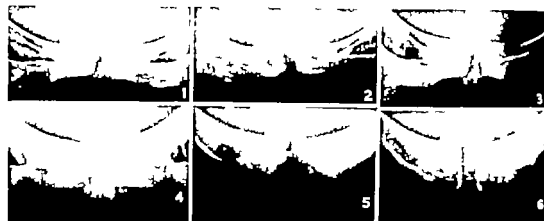


Fig. Symphysis at different times during pregnancy and postpartum. 1, 2, 3 are from a 3 year old primipara at 3 and 6 months and postpartum. 4, 5, 6 are from a 6 year old primipara at 3 and 6 months and postpartum. No definite changes can be found during pregnancy or as result of labor.

On the nineteenth day the patient was allowed out of bed and she walked on the twentieth day. There was only slight soreness over the symphysis on walking. This latter disappeared in week.

CASE 5. Mrs. C. A. aged 26 years, had had two uneventful pregnancies and spontaneous labors. Her previous medical history was normal except for the usual diseases of childhood and an appendectomy. Last menstruation began March, 1930, and labor began on December 8. There had been slight vaginal bleeding at irregular intervals for the past 3 weeks and the blood pressure on admission was 145/0. General physical examination was negative and the pelvic measurements were internicospine, 24 centimeters; intercrural, 37 centimeters; right oblique, centimeters; left oblique, 8 centimeters; conjugata externa, 30 centimeters; and the conjugata interna, plus centimeters. The first stage of labor lasted 4 hours and 45 minutes with severe pains at intervals. The second stage lasted 7 minutes and the delivery was spontaneous, the presentation being left occiput anterior. The child was female, 50 centimeters in length and 3,005 grams in weight.

On the third day the temperature was 100° F. degrees and the patient complained of severe suprapubic pain. There was marked tenderness over the symphysis, marked edema of the pubic region and vulva, definite mobility of the pubic bones and passive motion of the lower extremities increased the pubic pain. That night the patient became cyanotic, the respirations became rapid and the following day there was definite right sided pneumonia. On the fourteenth day pleurisy with effusion developed. This lasted for 3 days and was followed by complete recovery. The pubic pain had been relieved by immobilization by means of sandbags. X-rays of the symphysis showed no abnormal gap present. The patient was well on the thirtieth day and was discharged. Some tenderness was still present over the pubis and some pain was noticed when she walked. The gait was somewhat waddling but not waddling in character. Six weeks later the patient was examined and found to be normal.

The 63 case reports found in the literature together with the 5 here reported have been arranged and charted chronologically beginning with

Nicholson's report in 1824 (Table I). The most recent report found in the literature is that of Wu in 1930.

SYMPTOMATOLOGY

The time of onset of symptoms referable to separation of the symphysis pubis was recorded in 56 case reports. In 4 patients there were symptoms of pain, discomfort and difficulty in walking before delivery. Following delivery typical symptoms of separation developed. It would seem that these 4 patients had marked relaxation of the pelvic joints producing symptoms in spite of which traumatic separation, as evidenced by further symptoms and findings, occurred as the result of labor. Eleven women developed symptoms before labor had been completed, 10 immediately following delivery and 18 in the first 24 hours postpartum. The remaining 13 had no symptoms for the first day or even longer and developed their symptoms as they became more active. Three patients were apparently free from symptoms until they attempted walking or even standing.

The initial symptom of separation of the symphysis pubis is usually the occurrence of pain in the affected joint. Of the 67 case reports, pain is given in 53 as the initial symptom. Seven patients noted in addition to the pain, a cracking or tearing sensation. In 11 other women, the cracking could not only be felt but was recorded as having been audible to the attendants present at the time of delivery.

The predominating symptom of separation of the symphysis pubis is pain. This is located directly over the symphysis and is usually a co-

physis pubis has been recommended by Wishner and Mayer. The patient is encircled by a broad canvas swathe from behind forward and the two ends are run over pulleys, and weights varying from 5 to 25 pounds are attached. This swathe produces a continuous compressive force in the same arc but in the opposite direction to that of the pathological separation. The authors recommend this form of treatment as it is painless and because recovery is more rapid.

Occasionally healing and recovery of the joint is delayed or even absent. Open surgery of the joint with wiring or suturing of the pubic bones is then necessary. This was done in 2 of the 67 cases collected.

SUMMARY

The world literature to date has yielded only 62 instances of separation of the symphysis pubis during spontaneous labor, to which are added 5 additional case reports from the maternity service of the Michael Reese Hospital.

Of the various hypotheses offered in explanation of the occurrence of this lesion, the most logical is that "rupture of the symphysis pubis is due to marked intensity of the uterine contractions plus marked rapidity of labor." Analysis of the 67 case reports completely supports this theory of etiology, 73 per cent being multiparæ in whom the above mentioned intensity of contractions and rapidity of labor is most apt to occur. Thirty-nine per cent had contracted pelvises and 67 per cent had overweight babies. These two factors in the production of disproportion supply additional background for the fulminating type of uterine contractions.

The force that causes the separation of the symphysis pubis is a *wedge effect* produced by the violent thrust of the fetal head through the superior strait. This explanation of separation by a distention force is necessary since the available combined powers of the woman are approximately only one-quarter of the force necessary to rupture the symphysis pubis when applied by a direct pull.

Sacro-iliac involvement occurs when the separation is extensive and involves tearing of the ligaments on the anterior surface of the symphysis with only tenderness as a possible joint symptom. The right side is most frequently involved.

The bony gap demonstrable by X-ray or by actual palpation is never a criterion of the existence or the degree of the injury nor is it related to the severity or presence of the clinical symptoms and findings.

Separation of the symphysis pubis is rarely complete, a bridge of fibrocartilage nearly always

remaining. Hæmorrhage is usual and infection with or without abscess formation occurs when the injury extends into the vagina.

X-ray studies included an analysis of 70 individuals to establish a normal standard and repeated roentgenograms of 80 women at short intervals throughout pregnancy and the puerperium. A technique was evolved, and the semi-sitting posture was found to give the maximum opportunity for studying the symphysis pubis in the three projections.

While there are two generally accepted types of symphysis pubis, the male with deep and narrow joint and the female with the shallow and broad joint, these studies indicate that the sex type cannot be safely diagnosed from the contour of the symphysis pubis alone.

No characteristic changes in the symphysis pubis due to pregnancy could be determined by X-ray. In no instance in this series of 80 patients followed through the course of their pregnancy and puerperium could any definite changes be found in the joint.

Symptoms of separation of the symphysis pubis developed during labor or within the first 24 hours postpartum in the majority of instances. Pain in the affected joint is usually the first as well as the predominating symptom. In addition, a cracking sensation can be felt or even heard in some instances. Any movements which tilt the pelvic girdle increase the pain.

The typical physical findings are diagnostic and include œdema and swelling, tenderness, pain on pressure, and a waddling gait which is characteristic of the condition.

The complications of separation of the symphysis pubis include infection with or without abscess formation, sepsis, hæmorrhage, and failure of union. The mortality rate in the collected cases was 9 per cent. Recovery was complete within 2 months in over 60 per cent.

Separation of the symphysis pubis followed by complete recovery plays no rôle in subsequent labors, neither is the joint affected by subsequent labors.

The proper treatment consists in absolute bed rest with immobilization of the entire pelvic girdle. The simplest type of immobilization is by means of sandbags placed against the external surfaces of the lower extremities and of the hips. Circular adhesive tape may also be used for fixation. An occasional joint requires open operation and fixation. Circular compression by means of pulleys and weights is the most logical form of fixation. It has an especial value in those patients in whom the injury is not recent.

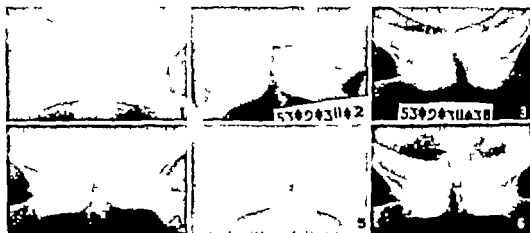


Fig. 13. The symphysis at term and postpartum. The patient is a 7 year old Negro. 1, 2, 3 are the three positions at term. 4, 5, 6 are the three positions postpartum. The contour of the joint remained unchanged in all three positions.

findings were corroborated on the operating table and in 2 at the postmortem table. Roentgenograms were recorded in 33. In 16 of these the films showed definite separation, and in the 7 remaining no diagnosis could be made from the films.

COMPLICATIONS

Abscess formation following traumatic separation was recorded in 7 instances, 10.4 per cent. Bladder trauma was present in 24 instances, a frequency in 36 per cent. There were 6 recorded deaths in this series, an incidence of 9 per cent. There were 3 deaths due to generalized sepsis following infection and abscess formation in the symphysis pubis, 2 deaths due to military tuberculosis following tuberculous of the traumatized joint, and there was 1 death due to extensive hemorrhage.

DURATION AND RECOVERY

The duration of this condition was recorded in 45 instances. The symptoms persisted for 1 month or less in 16; 2 to 3 months in 17; 3 to 4 months in 3; 4 to 5 months in 4; 5 to 6 months in 1; and longer than 6 months in 5. Complete recovery was recorded in 35 and a persistence of some symptoms with incomplete recovery in 2. Two other patients were cured by operation.

SUBSEQUENT LABORS

It is of special interest to note the effect of subsequent labors upon symphysis pubis that have healed following rupture in labor. Such a rupture might be presumed to predispose toward rupture in subsequent pregnancies or labors. Ap-

parently this is not the case. In this series, 1 patient had 3 subsequent labors, 2 patients each had 2 subsequent labors, and a fourth patient had 1 labor following the injury to the symphysis pubis. All of these 8 deliveries are recorded as being uneventful and without damage to the healed symphysis.

TREATMENT

The principle in the treatment of separation of the symphysis pubis is the immobilization of the entire pelvic girdle in order to put the joint at rest. In addition the tendency of the pubic ramus to pull further apart must be overcome. Sandbags placed against the external surfaces of the lower extremities from the iliac crests down to the ankles will bring about satisfactory immobilization, thus permitting healing and giving relief from pain. The objections to the sandbag method are first that the patient is allowed no movement in bed and secondly that the ends of the pubic bones are not brought together in order to hasten restoration of the torn pubic ligaments.

Broad adhesive strips, overlapping and passing from a line parallel to the posterior superior spine on one side anteriorly around the pelvis to the opposite side, will furnish complete immobilization of the joint in the majority of patients. In addition the patient may move in bed without producing any mobility of the symphysis pubis. Furthermore the lateral pull on the pubic bones is removed, thus permitting more rapid healing of the lacerated ligaments.

A method of applying even more powerful circular compression to the pelvis and to the sym-

RECENT DEVELOPMENTS IN THE TREATMENT OF GASTRIC LESIONS¹

WALTMAN WALTERS, M D , F A C S , ROCHESTER, MINNESOTA
Division of Surgery The Mayo Clinic

I SHOULD like to consider this subject from the standpoint of treatment of benign, ulcerating lesions of the stomach and duodenum as well as from that of the treatment of malignant lesions of the stomach of patients of all ages. It might be well, in considering gastric and duodenal ulcers, as they exist in patients in this country, to call attention to a few pathological differences in the two types of lesions. The principle fact in this connection is that ulcerating lesions of the stomach may be ulcerating carcinomata or carcinomatous ulcers, and I know of no scientific way of distinguishing between these two without microscopic examination of the removed lesions. The smallest gastric lesion may still be carcinomatous. I have, on a few occasions, removed carcinomatous lesions of the stomach no larger than 1 centimeter in diameter. Whether these started as carcinomata with areas of ulceration, or whether they started as ulcers and became carcinomatous seems to me to be only of academic interest, the fact remains that the lesions were carcinomatous and were not suspected of being such prior to operation.

ULCER

Ulcers of the first portion of the duodenum, however, practically never become carcinomatous, in fact, so seldom does carcinoma occur in the first portion of duodenum that its incidence there can be regarded as negligible.

It would seem necessary, therefore, to determine accurately the site of an ulcerating gastric or duodenal lesion, for if it is duodenal and produces few symptoms, without complications, a course of medical treatment should be properly carried out before surgical attack is considered. The value of a similar medical regimen for patients with gastric ulcers of small size has been evaluated by Eusterman and Jordan and by others, evidence of healing is disappearance of the niche of the ulcer as seen in the roentgenogram, with relief of symptoms and disappearance of occult blood from the stools. If any one of these three factors persists during the course of a properly regulated medical regimen, carried on over a period of a few weeks, the feeling of both internist and surgeon is that surgery should be done and the ulcer removed.

accomplished by cautery excision of the lesion and Surgical removal of such gastric ulcers can be

gastro-enterostomy, or by gastric resection, including the ulcerated lesion in that portion of the stomach removed. Although the recent wave of enthusiasm for gastric resection has prejudiced some in favor of gastric resection for all gastric and duodenal lesions, and although in certain types of lesions, such resections are the procedures of choice, yet it should be emphasized that excision of a gastric ulcer and gastro-enterostomy carries a lower operative risk than gastric resection, and furthermore recurring ulcer following the former procedure is practically absent.

The chronic duodenal ulcer, complicated by bleeding, perforation, or obstruction, is properly dealt with by surgical procedures. On the other hand, a duodenal ulcer without these complications, producing a mild degree of disturbance with little disability, and well controlled by dietary precautions, is a suitable case for a trial of medical treatment. This is particularly true if the duodenal ulcer has been producing symptoms for a short time, usually less than 3 years. In this connection, I think it is worth directing attention to the fact that in the last few years in The Mayo Clinic we have felt that in 55 per cent of the cases of duodenal ulcer a course of medical treatment was worthy of trial, whereas in the other 45 per cent surgical treatment has been considered, without dispute, to be necessary.

Experience has indicated that the proper selection of individual cases will assist materially in the benefits of whatever type of procedure, medical or surgical, is carried out.

Some surgeons, for instance Walton, of London, and Duval, of Paris, are of the opinion that the sooner a patient with chronic duodenal ulcer is operated on, the shorter is the period of disability and the less the necessity of an extensive operation. In further support of this opinion, Duval has expressed the belief that the duodenal ulcer which becomes chronic never heals by any measures other than surgical. Here, again, it would seem that decision as to the proper method of treatment in such cases is an individual problem.

I should like to call attention at this point to the fact that ulcerating lesions of the stomach and duodenum may vary in different races and in different countries. Recently, I have had an opportunity to study gross and microscopic speci-

CONCLUSIONS

1. Separation of the symphysis pubis during spontaneous labor is an unusual occurrence.
2. Separation of the symphysis pubis is due to "marked intensity of the uterine contractions and marked rapidity of labor."
3. Multiparity and relative disproportion are additional etiological factors.
4. Separation of the symphysis pubis is a result of the wedge effect produced by the violent thrust of the fetal head through the superior strait.
5. The bony gap demonstrable by X ray or by actual palpation is never a criterion of the existence or degree of the injury.
6. Sextype cannot be diagnosed from the X ray contour of the symphysis pubis alone.
7. No characteristic changes in the symphysis pubis due to pregnancy were found.
8. Pain is the initial and the predominating symptom of separation of the symphysis pubis.
9. The characteristic waddling gait is diagnostic.
10. The typical physical findings are edema and swelling, tenderness, pain on pressure, and the waddling gait.
11. Treatment consists in pelvic immobilization which can be achieved by sandbags, adhesive tape, open operation, or circular compression by pulley and weight.

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as the etiological factors concerned in the formation of ulcer are not definitely known, it is stated that surgical procedures should be delayed as long as possible. In reply to the criticism concerning recurring ulcer, the statistics would seem to indicate that among patients in this country, who have been subjected to conservative operations for duodenal ulcer, such as pyloroplasty and gastroenterostomy, the incidence of recurring ulcer is less than 3 per cent. This is true of any group reported or studied which consists of the usual type of American patient, a mixture of various races of the world, in fairly good health, except for the ulcer, living under good hygienic conditions, and eating according to a normal well balanced diet. If a higher incidence of recurring ulcer occurs, it is usually among certain races, and it is possible that in such a group the ulcerations more nearly approach those of the German speaking people.

In considering the uncertainty regarding the etiological factors concerned in the formation of ulcer, it might be well to recall that similar circumstances exist in cases of cholecystitis and renal calculi, and also in fibro-adenomatous hypertrophy of the prostate gland. Compare the etiological factors concerned in these conditions with those of gastric and duodenal ulcer. Does the balance weigh any more favorably in either direction as to results of treatment, or does the incidence of recurrence vary appreciably? I am sure that the general opinion is that the scale is in almost perfect balance, and yet, brilliant results are obtained in the treatment of such lesions when operative procedures are indicated for the removal of lesions or for the relief of obstruction.

I do not think apology is needed for the results obtained in surgical treatment of gastric and duodenal ulcer if indications for operative procedures are present, and if proper operative procedures have been carried out. In the few cases in which gastrojejunal ulcers develop, it often will be found that the original duodenal ulcer, for which gastroenterostomy had been performed, has healed, and that, after removal of the gastrojejunal ulcer, normal continuity between the stomach and duodenum or intestine can be restored with the expectation that as satisfactory a result will occur, without any greater incidence of recurrence, as after the non-operative treatment of duodenal ulcer. The only difference is, of course, that in the surgical case, when such procedure is carried out, the surgeon knows whether the duodenal ulcer is healed. In other cases, after removal of gastrojejunal ulcer and closure of the openings in the jejunum and stomach, pyloroplasty, with removal of the original ulcer, may be advisable. In some

cases of extensive gastrojejunal ulceration, or in cases in which the original ulcer does not appear to have healed properly, or, in healing, has narrowed the first portion of the duodenum so that satisfactory pyloroplasty cannot be carried out, gastric resection is indicated. Such procedure in the treatment of gastrojejunal ulceration at the clinic in 1930 carried a mortality of 3.5 per cent.

The duodenal ulcer which bleeds is worthy of special attention. Such ulcers may be multiple, but if the ulcer is single it is usually situated on the posterior wall of the duodenum and perforation has taken place into the pancreas. A small blood vessel in the crater of such a perforating ulcer usually will be found to be the cause of the hæmorrhage. It has been my custom in such cases, whenever possible, to remove or destroy the lesions, either by cautery or resection of the ulcer. If resection is advisable, pylorotomy, combined with resection of as much of the lower end of the stomach as is thought desirable, reconstructing the anastomosis to resemble that of the Billroth I procedure, has served admirably. When the ulcers have been small, and have been situated only in the anterior wall, excision, combined with one of the plastic procedures, has worked out very satisfactorily. Unfortunately, in many cases of bleeding duodenal ulcer, the large size of the lesion, the subacute inflammation, and the immobility of the first and second portions of the duodenum, make excision or resection of this portion of the duodenum exceedingly hazardous. In these cases, the patient is much better off, and certainly the surgeon is assuming much less risk with gastroenterostomy, which will prevent recurrence of the bleeding in 80 per cent of these cases, than if a direct attack on the lesion is attempted. Should bleeding recur after gastroenterostomy, a secondary operation always can be undertaken at which time it is usually possible to remove the bleeding, ulcerating portions much more easily and much more safely to the patient, because of relief of the inflammatory œdema, by proper drainage of the stomach, brought about by the previous gastroenterostomy.

CARCINOMA OF THE STOMACH

There is no need, I believe, to review the various types of restoration of gastro-intestinal continuity after resection of the stomach. It might be of interest, however, to know that the posterior Pólya, the anterior Pólya-Balfour, and the Billroth I procedures are most commonly used at the clinic.

The Pólya type of operation is widely used in this country, but the Billroth I operation has not

mens of ulcerating lesions of the stomach and duodenum found at operation in Germany, Austria, and Hungary. The characteristic features of ulcerations of the stomach and duodenum in these countries are the multiplicity of lesions in both the antrum of the pylorus and in the duodenum, generally in France and the United States of America, the ulceration tends to localize either to the duodenum or the stomach. In referring to the literature on the subject in German, one is struck by the fact that these lesions are referred to as "peptic ulcers," and such they are, for in practically every specimen associated with one or more duodenal ulcers, there were from three to sixteen superficial yet definite ulcers in the antrum of the stomach. The ulcers of the antrum varied from 0.3 to 1.5 centimeters in diameter, were superficial, and extended to the muscularis mucosa, and associated with them in many instances was extensive gastritis of the antrum. Konjetzny in his monograph entitled "The Inflammatory Bases of Typical Ulcer Formation in the Stomach and Duodenum," published colored photographs of gross specimens as well as microphotographs of these lesions. It seems probable, therefore, that pyloroplasty or gastro-enterostomy in these cases is followed by an incidence of recurring ulcer out of proportion to the recurrence in this country owing to the fact that the stoma of pyloroplasty or gastro-enterostomy would be placed directly in the infected, ulcerating area of the stomach. It is obvious, I believe, that when such diffuse ulceration exists in the stomach and duodenum, resection of the portion containing the ulcerations, by partial gastrectomy should be the operation of choice.

That most duodenal ulcers occurring in patients in this country are localized to the duodenum, and are not accompanied by ulceration of the antrum of the stomach, can be justified by the observation of most surgeons who have carefully noted the condition of the antrum of the stomach at the time pyloroplasty or gastro-enterostomy has been carried out. Shortly after my return from Europe I had occasion to resect the stomach of 5 patients with ulcerated lesions. In 3 cases, the resections were done for gastrojejunal ulcers in 1 of which the complication followed gastro-enterostomy and in the other a Devine exclusion type of operation. In 2 other cases, resection was done for a bleeding, perforating duodenal ulcer. In only 1 case of the 5 were superficial ulcers found in the antrum of the stomach in addition to the duodenal ulcers, and in this particular case the ulcers were known to exist prior to operation; diagnosis had been made by the roentgenologist and had been suspected by the

clinician. In this case therefore, with multiple ulcers of the stomach and duodenum, resection of the ulcerated region was indicated. In the 1 case in which there were hemorrhagic duodenal ulcers, there was no evidence of ulceration in the antrum of the stomach.

It would seem, therefore, that the problem of duodenal ulcer which concerns the surgeon in this country is whether definite, grossly visible ulceration exists in the antrum of the stomach, associated with duodenal ulcer. If not, conservative procedures, such as excision of ulcers, and pyloroplasty and gastro-enterostomy are indicated. Is the experience of the clinic, such procedures are carried out with a mortality of less than 1 per cent, and with permanent cure in more than 90 per cent of cases. If the ulcerations are diffuse, and if they involve the stomach and duodenum, partial gastrectomy is advisable. Because of the fact that partial gastrectomy for ulcer carries a higher mortality than the conservative operations of pyloroplasty and gastro-enterostomy the burden of proof rests on the surgeon who advises subtotal gastrectomy for duodenal ulcer.

Why one type of lesion should be present in central Europe and not in Paris, and in but few cases which we have seen at the clinic, is difficult to determine. This difficulty of interpretation is not to be wondered at when it is considered that doubt still exists as to the etiology of duodenal and gastric ulcers, even though a period of 35 years has elapsed since surgical treatment has been recognized as being of utmost value in the handling of most of these cases. Yet, when there is unanimity of opinion regarding the value of a certain operation among certain surgeons in any country for the treatment of a particular disease, it can be said that the results justify such a procedure. In the large clinics in Germany, Vienna, and Budapest, all surgeons of whom I know perform gastric resection for the ulcerating lesions which have been mentioned. In Paris, where evidence seems to indicate that the lesions also are not diffuse, procedures such as pyloroplasty with removal of the duodenal ulcer or gastro-enterostomy are the general rule except in our large clinic. In the United States, although a few surgeons have advocated gastric resection, as a routine for duodenal ulcers, an overwhelming majority favors selections of the procedure indicated, whether it be gastro-enterostomy, pyloroplasty or gastric resection.

In evaluating the results following the surgical treatment of duodenal ulcer criticism has arisen, largely due to two factors: (1) ulcers may recur following operative procedures and (2) transmo-

removed from it. Furthermore, I am not convinced that metastasis in the liver of a patient who is in good condition should prevent palliative removal of an ulcerated, infected gastric lesion. There is no reason why such a necrotic, sloughing tumor should not be removed, and actual or impending obstruction relieved, if by such a procedure the remainder of the patient's life may be made more comfortable. I know of several such patients who have lived more than 3 years and been able to carry on their work with comfort. In this connection it should be remembered that death due to metastasis to the liver is usually

painless, probably because the metastatic hepatic lesions do not break down or become infected. Whether such palliative resection should be done is a decision to be made in each case, yet the principle established by Sampson Hanley in his treatment of carcinoma of the breast, in my opinion applies equally well to treatment in cases of gastro-intestinal carcinoma, which briefly is that the field should be extended not only to include early cases of malignancy, but also late cases and recurring cases, if by so extending it the remainder of the patient's life can be made more comfortable and can be greatly prolonged.

been so extensively employed. There has been hesitancy in carrying out the Billroth I operation because it was originally discarded by Billroth owing principally to what he thought was a dangerous suture angle formed at the point of meeting of the three lines of suture in the anastomosis, as well as to the fact that little has been written of the indications for the operation or the results following its use in different types of cases. In the last few years I have used this method of gastric resection in more than 50 cases, both for carcinoma of the stomach and for gastric or bleeding duodenal ulcers.

The Billroth I operation consists of resection of the portion of the duodenum containing the lesion. If an ulcer exists or of that portion of the stomach containing the ulcer or carcinoma, with direct anastomosis between the upper end of the stomach and the duodenum the stomach is narrowed by suture to the extent that the opening in it is similar to that of the duodenum. The essentials and safety of the operation are dependent on their being sufficient normal stomach above the gastric lesion to be resected so that the anastomosis can be made to the duodenum without tension, and exposure of the first and second portions of the duodenum can be made with sufficient ease to make such anastomosis accurate. In cases in which the caliber of the duodenum has appeared to be small, I have not hesitated to extend the excision down its anterior wall, thus giving as large a size to the anastomotic opening as is desired. Illustrative of results of the operation are 4 cases of carcinoma, graded 1 or 2 without lymphatic involvement, in which the growths were removed successfully and gastroduodenal continuity restored by the Billroth I procedure.

The oldest patient was in her seventy-eighth year, and was operated on in March, 1930 she has been perfectly well since the operation. This patient had gastric retention owing to the site of the lesion at the pylorus, and quantities of gastric content, varying from 100 to 1500 cubic centimeters, could be recovered. It was necessary because of the size of the carcinoma, to remove three fourths of the stomach. This case illustrates the fact that indications for the operation depend not particularly on the amount of stomach removed but on the necessity of the anastomosis between the end of the stomach and duodenum being made without tension. Whenever pre-operative obstruction has occurred in such cases, particularly in elderly patients, I have felt it advisable, in addition, to perform temporary jejunostomy for feeding, which gives complete control of the patient's nutrition. The 3 other

patients, all aged more than 70 years, returned home in good condition.

Total gastrectomy. Attention should be called to the fact that total gastrectomy could probably be done in more cases. Such a possibility supports the surgeon in his decision to advise exploration in cases of carcinoma of the stomach regardless of its extent as evidenced by roentgenological examination provided the condition of the patient permits. Not infrequently a lesion reported as inoperable by the roentgenologist, because of its extent, is found to be removable.

Total gastrectomy has been performed ten times at the clinic five operations were performed in the last 3 years and three of these in the last year and a half. Mention is made of this because of the fact that the use of spinal anesthesia and a left rectus incision have permitted more easy exposure of the lower end of the esophagus than of the fundus of the stomach. In such cases, the question frequently has been raised as to the effect of loss of the entire stomach on the general physiological processes. In this respect, it may be noted that one of the patients successfully operated on by W. J. Mayo lived for almost 4 years. Moynihan and Brigham each reported a case in which the patient was living and well for more than 2 years following the performance of a total gastrectomy.

Physiological and chemical studies following successful total gastrectomy which I performed September 10, 1929, carried out over a period of 4 months subsequent to operation, did not reveal any appreciable change in the number of erythrocytes in the concentration of hemoglobin in the carbon dioxide combining power or in the concentration of blood chlorides of urea. A second case in which I operated successfully December 30, 1930 is being studied similarly to serve for comparison with the other cases. At the present time (August 24, 1931) the patient is in good condition.

Presence of metastasis. The presence of metastases in the cervical lymph nodes (so called signal glands) or in the region of the umbilicus when the nodes are definitely proved to contain carcinomatous cells by excision of one of them and its microscopic examination is in general a contraindication to operation. The same general statement applies to pelvic implants palpated on the rectal shelf on rectal examination. On the other hand the presence of a small tumor in the liver, existing with a carcinoma of the stomach should not be taken to be a metastatic nodule unless proved so by microscopic examination of a section

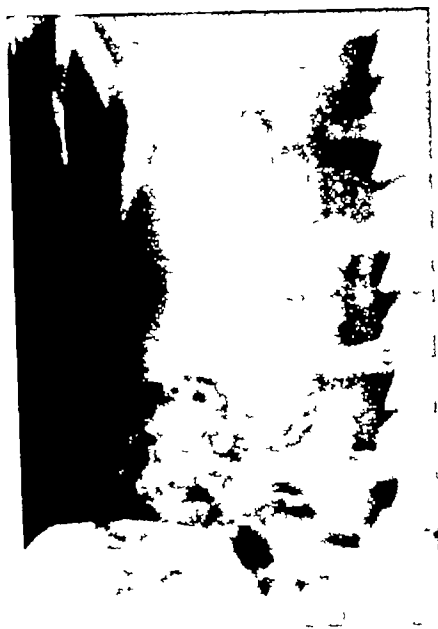


Fig 1 Multiple shadows in right renal area



Fig 2 Stone masses showing in pyelogram as areas of decreased density

The important point in this case to which attention is invited is the nature of the pelvic concretions. The density of the stones was less than that of the pyelographic material. This is rather an unusual occurrence and indicated that only a small amount of shadow-casting material was present. Usually traces of calcium, sodium, and phosphate are found.

A nephrectomy was done as it was impossible to remove all the soft, putty-like material, and this kidney was functionless and not essential. The opposite kidney was entirely sufficient to support life. The patient lived in an inaccessible district where it was difficult to obtain medical care. If the kidney had not been removed and a more conservative procedure attempted, it might later be found necessary to resort again to surgery.

CASE 2 A woman, aged 61 years, had had an occasional attack of pain in the right loin during the last 5 months. The pain usually lasted from 1 to 2 days. Her last attack began 5 days ago. It was of moderate intensity, fairly persistent, and was associated with a generalized jaundice. She was slightly nauseated and had moderate frequency of urination. Previous to the past 5 months she had always considered herself well except that, for the last 20 years, she had had twinges of pain and a sense of discomfort under the right costal margin. She had a good appetite, could eat any food without distress, and did all of her house work.

Examination revealed a thin, small woman with a definite generalized jaundice. The right kidney was tender,

easily palpated, and freely movable. The liver edge could be felt below the costal margin and was somewhat tender.

Laboratory data The urine contained a large amount of pus, some bile, a few red blood cells, and a trace of albumin. The 2 hour intravenous phthalein return was 47 per cent. X-ray examination of the kidneys and bladder revealed a somewhat indistinct shadow 2 by 3 centimeters in the region of the right kidney.

Cystoscopy The urine from the left kidney was clear but that from the right was cloudy and contained pus and blood. The 15 minute phthalein return was 2 per cent on the right side and 14 per cent of the left side. A right pyelogram included the shadow seen in the original X-ray picture. As the patient was recovering from her pain, she was kept waiting for 2 months before any surgical procedure was attempted, during which time her jaundice cleared up completely, she gained weight, and felt in much better health.

Operation The kidney was delivered through a right posterolateral incision. It was about 5 centimeters below the normal location and moderately adherent to the overlying fat and to the peritoneum, though quite freely movable. The liver extended down about 3 centimeters below the costal border. When the peritoneum was stripped, there was considerable studding of the renal surface. The cortex was hard and firmer than normal kidney tissue, suggesting an extensive fibrosis. The kidney was about normal in size but contained very little tissue which appeared or felt normal. The kidney pelvis was slightly dilated, thickened, and the ureter was 1 centimeter in diameter, with thickened, stiffened walls. The pelvis was opened and a large amount of soft putty like stone material extruded. There was also a large amount of mucus and necrotic tissue expelled through the opening. The vascular pedicle and ureter were clamped, cut, and tied separately and the kidney was removed.

SURGERY GYNECOLOGY AND OBSTETRICS

BACTERIAL CONCRETIONS IN THE KIDNEY PELVIS

WITH REPORT OF TWO PERSONAL CASES¹

A. J. SCHOLL, M.D., F.A.C.S., LOS ANGELES, CALIFORNIA

OCCASIONALLY there are met in the literature reports in which so called bacterial or fibrin concretions are described as found in the kidney pelvis either at autopsy or operation. Such masses are soft and friable and consist of a nucleus or layers of fibrin with perhaps a few crystals among them. Gage and Beal collected a series of soft fibrous kidney concretions in 1908 and the literature contains some isolated reports since then.

Apart from these fibrous calculi, however I wish to report here on another much rarer type of soft kidney stones, namely concretions composed entirely of bacteria. Only a very small number of cases of this type have been reported and these I will refer to later on. In Israel's book, *Chirurgie der Niere und der Harnleiter* 1925 p 234, four such cases are mentioned. These concretions are described as "soft, elastic bodies varying in size from that of a bean to a cherry, occurring in the pelvis of the kidney round, oval or tetrahedral in shape, and composed entirely of coil bacteria."

I have had two personal cases of this latter nature, the histories of which are as follows:

CASE 1. A woman, aged 34 years, had been feeling discomfort in the right loin for 15 years. During the last 3 years she had definite attacks of pain in the right kidney region that were occasionally associated with chills and fever. The pains were usually of short duration, of moderate intensity and were frequently followed by the passage of one or more stones. Altogether she had passed about six or seven stones. They were about the size of a bean, soft and elastic and could easily be crushed between the fingers. Four years ago she had a right nephrectomy at which time a single large stone was removed (details as to the size and consistency of this stone were not available). She had a very stormy convalescence following her operation which did not interrupt the passage of stones, as she passed several days after the operation and has continued to do so every few weeks for years and present time. During the past 5 years her urine has been cloudy and contained pus, but she has had very little blood and has continued to do her very little work. Physical examination revealed an emaciated woman, bladder pain or frequency of 15 pounds, had almost constant micturition. The right kidney which could be palpated, was to the right costovertebral angle, weighing 105 pounds. There was a large amount of pus and blood in the right costovertebral angle. The urine contained a large amount of pus and blood. The 1 hour intravenous injection of phenolsulfonphthalein was 50 per cent. A roentgenogram of the kidneys and bladder revealed numerous black faint shadows

in the region of the right kidney (Fig. 1). The shadows varied in size from 1/4 to 3/8 centimeter; they were confined to a small, definite area, similar to the localized shadow of gall stones. Several of the shadows were laminated but they were without the outside dense ring so commonly seen in gall stones. An X-ray of the urinary tract after the injection of gall bladder dyes revealed a normal sized, well defined gall bladder separate from the shadows previously noted. Cystoscopy revealed an almost completely normal right kidney. A right pyelogram showed an enlarged, dilated pelvis containing numerous areas of lower density corresponding to the shadows seen in the original X-ray picture (Fig. 2).

Operation. A right posterolateral incision was made below and posterior to the previous incision. The kidney was readily delivered but the capsule border was usually adherent to the psoas. It was necessary to use sharp dissection to free these adhesions; the capsule in one area was stripped from the kidney and a portion left adherent to the psoas.

The kidney was soft, pronephrotic, and contained only small amount of functioning tissue. The pelvis was dilated and thickened and contained what seemed to be a soft elastic mass. No definite scars could be felt. The renal vessels and the ureter which was thickened and dilated, were clamped and cut and the kidney removed. The patient recovered uneventfully.

Pathological report. The removed kidney was normal in size and lobulated. The capsule of the kidney was thick and adherent. The convoluted of the kidney was thick and the mucous membrane was thick. The kidney was opened, the mucous membrane was thick and dilated, and the mucous membrane was thick. There were several scars in which the cortical substance was destroyed. The pelvis was almost completely filled with soft, friable, grayish-yellow stones; there were about twelve of these stones measuring from 0.5 to 1 centimeter in diameter. Most of the stones had flattened surfaces due to pressure (Fig. 3). The outer surfaces of the stones were smooth and rubbery and the flattened surfaces resembled the flattened surfaces of the stones occurring with gall stones. The stones could readily be crushed with forceps or flattened between the fingers. Examination of the soft elastic material composing these stones by placing a portion in a drop of water and observing microscopically showed large numbers of bacteria (bacillus coli) with few red blood cells and leucocytes. Culture of the mass material showed growth of bacillus coli with occasional colonies of streptococci. The entire stones were composed of bacteria. Examination of cut or crushed stones from either the surface or the center of cut or crushed stones revealed the same condition.

The kidney parenchyma was moderately fibrotic. Between these showed large scars in the center in which there were many fibrotic glomeruli, atrophy of the tubules, heavy round cell infiltration, and more or less hemorrhage. Between the scars the glomeruli were congested and the tubular epithelium showed marked granular swelling. The pelvis mucosa was thickened and heavily infiltrated with round cells (Fig. 4).

onset of symptoms, there were several mild attacks of colic during which forty-one "soft" stones were passed. Subsequently, the calculus seen by X-ray was eliminated, together with three others of the "soft" variety. Nearly 100 more soft stones were passed during the following 10 months. Ward found that a pyelogram showed the right kidney dropped and ureter kinked below the pelvis. Some months later there was another attack of persistent pyuria and obstruction of the right kidney with signs of inflammation, and the kidney was removed. The urine had shown abundant bacillus coli. The patient recovered. The removed kidney contained over one hundred calculi which, on examination, were found to be of laminated structure and composed almost entirely of bacteria more degenerated toward the internal part of each lamella. From the chemical examination the nucleus of these calculi seemed to be a minute blood clot with the outer layers composed entirely of bacteria. The cementing layers appeared to be of a mucoid nature which, Ward presumed, was the factor necessary for cohesion.

Kelly and Dible observed a case in a woman of 42 years. Her symptoms dated back to the age of 8 years, when she was treated for some urinary condition. A few years later she had a definite attack of pyelitis which involved the right kidney, and, about 10 years or so later, an attack of painless hæmaturia.

X-ray examination disclosed nothing, but by the cystoscope the presence of a calculus in the right ureter was diagnosed. Occasional attacks of hæmaturia followed but later X-ray examinations failed to locate the stone again, and it was presumed to have disintegrated. Bacillus coli and blood were found in the urine which also contained casts composed chiefly of bacteria. Exploration of the right kidney pelvis resulted in the removal of masses of calcareous and soft, friable material from the kidney pelvis (calcium oxalate and fibrin). This woman was ultimately nephrectomized in 1929 (15 years after the last cleaning out of the kidney pelvis), on account of agonizing pains and loss of right kidney function. The whole of the kidney pelvis and calyces were tightly packed with soft, faceted, dark olive green masses. In some cases there was a very minute calcareous nucleus. Microscopically the concretions were composed of bacillus coli and a reticulum substance of the nature of fibrin which was about the masses of bacteria. The authors, however, think that this was not fibrin but largely composed of degenerate leucocyte cells. There was some kind of stratification of the outer layers,

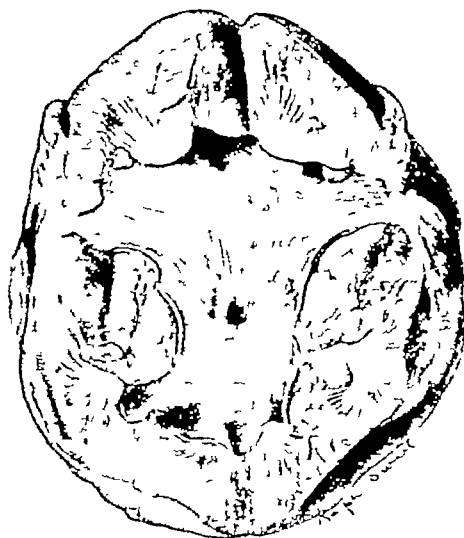


Fig. 4. Partially destroyed kidney after removal of stones. Scar of previous nephrotomy indicates destruction of large area of renal parenchyma.

but this was entirely lacking toward the center of the concretions.

ETIOLOGY OF BACTERIAL RENAL CONCRETIONS

From a consideration of the cases quoted and of the literature, two questions arise in the etiology of this particular type of concrement: first, that of some kind of nucleus, and second, that of some kind of cementing process which causes the masses of bacteria to adhere. There seems to be little doubt that the concretions develop by continual proliferation of live bacteria and the addition of cells to exterior of growing mass.

In regard to the nucleus, Lauda postulated the presence of necrotic shreds cast off from the pelvic wall in pyelitis. Many of the cases gave the history of an old pyelitis, but, if this is to be considered as causative, the occurrence of bacterial concretions should be much more common than they apparently are.

Schmorl thought the first event to be a simple adhesion of bacteria to form small masses. The urine from an infected renal pelvis not infrequently contains clumped masses of bacteria, at times these are sufficiently large to obstruct the ureteral catheter. It seems quite probable that a number of these clumps might coalesce and form the nucleus of a larger mass.



Fig. 3. Soft, faceted stones in kidney pelvis. On section some show a laminated structure.

Pathological report. The specimen consisted of a small kidney measuring 9.5 by 4.5 by 3 centimeters. The pelvis was moderately enlarged and contained five soft, light brown stones. These were very soft so that they could be crumbled between the fingers. Examination of the material composing these stones, by placing some in a drop of water and examining microscopically, showed large numbers of bacteria (*bacillus coli*). Cultures taken from the surface of the stones or from the central portions of crumbled stones revealed a growth of *bacillus coli*. The mucosa membrane of the pelvis was distinctly thickened and congested. The renal parenchyma was pale, firm, and rubbery and apparently markedly fibrotic.

Sections showed a very diffuse, fibrous, extensive atrophy of the tubules, many glomeruli were surrounded by fibrous tissue. There was an extremely heavy round cell infiltration throughout. At one place in the pelvis was an organized thrombosis. In places the tubules were hypertrophied.

In this, as in the previous case, it was possible to obtain active colon bacilli or a positive culture from any part of the stones either on the surface or from the cut section. In both cases the kidneys were partially or almost completely destroyed and in such a condition that it would be impossible to obtain a permanent cure by attempting to remove the stone fragments.

Due to the lack of normal kidney tissue or function on this side the displacement of the kidney, the extensive fibrosis, the patient's age and because of the normal function of the opposite kidney, a nephrectomy was done.

The definite jaundice that was seen 2 months before operation was probably due to the down-

ward pull of the heavy fibrotic kidney on the biliary passages. It has been shown that a right movable kidney drawn forward and downward causes traction on the duodenum at a point 2 or 3 centimeters below the entrance of the biliary tract and though it does not occlude the lumen, it may interfere with the contents of the bowel sufficiently to impair digestion and to cause biliary obstruction. Some investigators believe that the jaundice associated with movable kidney comes from a pull on the fixed, descending part of the duodenum and obstruction of the papilla of Vater.

REVIEW OF LITERATURE

The cases mentioned in Israel's book are those of Schmorl, Jores and Neumann. In Schmorl's first case the autopsy of a 58 year old woman, who died of lung disease but showed evidence of cystopyelitis, disclosed a bacterial (*bacillus coli*) calculus in the kidney pelvis. In Schmorl's second case a woman of 81 years gave a history of cystitis. Following a kidney colic, bean-sized bacterial (*bacillus coli*) calculi were passed 4 days before death. Jores found the same picture *intra vitam* in urine and in a kidney colic. In Neumann's case pea to cherry-size concretions were found embedded in pus in the pelvis of a woman of 50 years who had had a nephrotomy. Microscopically and culturally these concretions were found to be composed of *bacillus coli*. Later this patient showed a right sided pyelonephritis.

Bornemann described a case of a girl aged 7 years with a history of whooping cough and colic. At the age of 4 years she had hematuria and intense pain. Blood clots were passed at the end of urination. The urine showed much albumin, pus, bacteria (cultured as *bacillus coli*) and casts, and X-ray examination disclosed shadows in each kidney pelvis. The child was treated medically and died. At autopsy a hard stone was found in each kidney pelvis, besides a large number of soft, laminated, spheroid concretions the largest, walnut sized. Microscopic examination showed that the soft laminated concretions in both pelvis were composed entirely of *bacillus coli*, the segmental layers containing leucocytes, red blood cells, and necrotic epithelial cells.

In a case reported by Ward, the patient was a woman of 35 years who had had malaria and typhoid as well as a history of bowel disorder. Fifteen months before coming to Ward she had had a severe right renal colic with hematuria which lasted a month then another colic on the same side accompanied by acute renal infection. X-ray examination showed a calculus. About a month later that is about 3 months after the

onset of symptoms, there were several mild attacks of colic during which forty-one "soft" stones were passed. Subsequently, the calculus seen by X-ray was eliminated, together with three others of the "soft" variety. Nearly 100 more soft stones were passed during the following 10 months. Ward found that a pyelogram showed the right kidney dropped and ureter kinked below the pelvis. Some months later there was another attack of persistent pyuria and obstruction of the right kidney with signs of inflammation and the kidney was removed. The urine had shown abundant bacillus coli. The patient recovered. The removed kidney contained over one hundred calculi which, on examination, were found to be of laminated structure and composed almost entirely of bacteria more degenerated toward the internal part of each lamella. From the chemical examination the nucleus of these calculi seemed to be a minute blood clot with the outer layers composed entirely of bacteria. The cementing layers appeared to be of a mucoid nature which, Ward presumed, was the factor necessary for cohesion.

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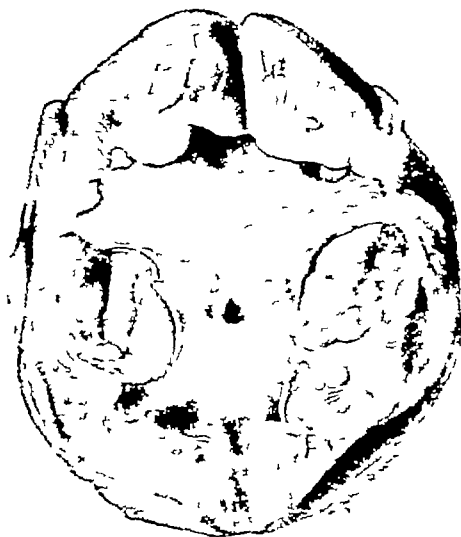


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Bornemann discusses the similarity of fibrin stones and bacterial stones and concludes that they are identical. The nucleus of the concretions in Ward's case appears to have been a minute blood clot. Kelly and Dible conclude that the concretions were originally formed about tiny particles of stone or gravel.

The most important factor in these cases, however, appears to be the continuous deposit of bacteria in the kidney pelvis. This point, as well as the fact that the particular bacillus is almost always the bacillus coli, seems to have received very scant consideration from the authors. Ward thinks that in his case the bowel disorder may have been the source of the urinary tract infection and that the process was intensified by the presence of kidney ptosis and ureteral kink. The fact that all the cited cases were in women and that kidney ptosis is more common in the female sex may have some bearing in the matter.

There seems but little to support the theory that the cementing substance in the concretions is of a fibrinous nature. It seems more plausible to consider it to be a degenerated leucocyte product.

In my own two cases there was no evidence of a calcareous or fibrinous nucleus, nor did the urine contain fibrin shreds.

I do not wish to include in this report cases in which bacilli other than the bacillus coli were cultured from the kidney pelvis. Liebermeister mentions 3 cases of tuberculosis of the kidney with calculus in which the tubercle bacillus was found in the stone, and Ferrier and Bliss report a case of pyelithotomy complicated by gas bacil-

lus (bacillus welchii) infection originating in the nucleus of a renal calculus.

CONCLUSIONS

Two personally observed cases of kidney pelvic concretions composed of bacteria (bacillus coli) are reported and some other cases reported in the literature are discussed. Continuous infection of the kidney seems necessary but it is likely also that some special circumstance is called for in order that a calculus of this type should be produced.

Bacterial concretions in the kidney pelvis may be concomitant with the usual type of indurated kidney calculus.

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ACUTE HEAD INJURY

A STUDY OF ONE THOUSAND CASES¹

S. BERNARD WORTIS, M.D., AND FOSTER KENNEDY, M.D., NEW YORK

THIS study of 1,000 cases of acute head injury admitted to Bellevue Hospital represents a group clinically diagnosed "Fracture of the Skull." Head trauma should be classified clinically by its resultant pathology, accordingly the following plan is offered:

- I Simple scalp wounds
- II Skull fracture with or without associated brain injury
 - a vault
 - b base
 - c simple (linear or comminuted)
 - d depressed
 - e compound
- III Brain injury with or without associated skull injury
 - a Concussion
 - b Cerebral edema
 - c Cerebral contusion
 - d Cerebral laceration
 - e Hemorrhage-intradural, extradural, or both
- IV Combinations of the above

The material reviewed was admitted for study only on the presence of one or more of the following positive criteria following severe injury to the head: (1) postmortem evidence of skull fracture or brain laceration, (2) positive X-ray evidence of skull fracture, (3) bloody spinal fluid obtained by lumbar puncture.

Mortality rate. The mortality rate of the entire group was 37.8 per cent. This was found to vary slightly from year to year as shown in Table I.

TABLE I—MORTALITY RATE

Mortality percentage	Lived	Died
1000 cases	62.2	37.8
Mortality percentage according to years		
1926	62.6	37.4
1927	65.7	34.3
1928	59.4	40.6
1929	60.9	39.1

There appears to be a definite increase in the death rate associated with increasing age. In children under 12 years of age the death rate

was 25.8 per cent, whereas in people over 60 years the mortality was 49.6 per cent (Table II).

TABLE II—MORTALITY RATE ACCORDING TO AGES

Cases	Age Groups	Mortality rate per cent
97	0 to 12 years	25.8
782	13 to 60 years	37.5
121	Above 60	49.6

Types of trauma. Automobile accidents and falls are the commonest causes of acute head injury as shown in Table III.

TABLE III—TYPES OF TRAUMA

	Cases
Auto	266
Street car	17
Bicycle	2
High fall	86
Low fall	135
Fall down stairs	95
Assault	33
Horse kick	1
Blunt instrument	22
Falling object	21
Flying object	2
Moving object	12
Crushing object	5
"Fight"	18
Unknown	285
Total	1000

Local scalp condition. The associated local scalp condition was reported in 713 of the cases and these findings are grouped as in Table IV.

TABLE IV—LOCAL SCALP CONDITION

	Right	Left	Both sides	Location not specified	Total
Laceration	1.9	193	20	107	469
Hematoma	47	58	7	42	154
Echymosis or contusion	25	31	2	26	84
Edema	0	3	0	2	5
Abscess of the scalp	0	0	0	1	1
Total	211	285	29	178	713

X-ray evidence of fractured skull. Roentgenograms were made in only 499 of the 1,000 cases. Of these 230 were negative, 186 showed fracture of the vault, 63 showed fracture of the base, and 20 gave evidence of depressed fracture of the cranium (Table V).

¹Neurological Department (Cornell) Bellevue Hospital, New York City.

TABLE V—X RAY EVIDENCE OF FRACTURED SKULL.

	Lined %	Blank %	Total %	Total number cases
Positive roentgenogram of the vertebra	17.5	3	8.6	166
Positive roentgenogram of the lower extremities for de-	1.6	7	6.3	63
pressed fractures	0			0
Negative roentgenogram			6.2	30
Röntgenogram not made	5.5	24.6	30	300
				1,000

TABLE VII.—POSTMORTEM FINDINGS

	Right	Left	Midline	Side not specified	Total
Fracture lines and vault					
Posterior location					
Laminate					2 1/2
Composite		7			7
Lateral location					
Laminate	27				27
Composite	3	6			9
Anterior location					
Laminate					1
Composite	3	3			6
Vault fractures					
Laminate	16			3	19 1/2
Composite		3			3
Deformed					
Total	24	64	—	3	91

Abstract

Fractures described as category			
Fractures present but not described			
Autopsy but no skull fracture found			
<hr/>			
Total number of cases with autopsy			87
<hr/>			
Percentage of cases with autopsy	Of patients died of		
(of total)	(see)		per cent
<hr/>			
Percentage of autopsies showing fractures of the skull			per cent

TABLE VII.—POSTNORTHAM FIREBOX (Continued)

[illegible]

TABLE VIII —SITES OF HÆMORRHAGE

	Cross %	Local %	Dev %
Bleeding from at least one orifice to nose, mouth, or throat	70	21.5	57.6
No bleeding from orifice	30	78.5	42.4
Unexplained (unexplained charts)	4.8	0	0
Bleeding from the nose*	1.7	20	13
Bleeding from the ear*	24.7	21	11
Bleeding from the mouth	15.8	0	30
Excess mucus about the eye*	0	6.9	6
Subconjunctival hemorrhage*	2.7	3.2	0

*Also occurring in children.

TABLE VI—TIME UNCONSCIOUS—MORTALITY—LUMBAR PUNCTURES

	Met uncon- scious	No respon- sive	Tame unre- sponded	Fro m sides	"Short"	Long"	Movements							
									W	S	W	W	W	W
Steady tap	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T
Clear tap	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T
Cloudy tap	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T
No tap	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T	11L 10D 4T

Summary

	Lived	Dead	Total
Steady tap	11	10	21
Clear tap	11	10	21
Cloudy tap	11	10	21
No tap	11	10	21

(Probably small amounts of blood—no organisms reported)

Total number of cases
1. Lived, D. dead, T. total, dead without responding consciousness

TABLE IX—TIME IN HOSPITAL

Time in hospital	Lived	Died	Complication	Oper on lived	Oper on died	Transferred	Left against advice
On admission		10					1
1- hour		5					
1/2 to 1 hour		9					
2 hours		17					
3 hours		13					
4 hours		14					
5 hours		8					
6 hours		7			1		
7 hours		6					
8 hours		6					
9 hours		5					
10 hours		1					
11 hours		3					
12 hours		2					
13 hours		1					
14 hours		2			1		
15 hours		2					
16 hours							
17 hours		3					
18 hours		1			1		
19 hours		1					
20 hours		1					
21 hours		2					
22 hours							
23 hours							
24 hours (approximate)		38			5		3
2 days		5			4	1	10
3 days	1	8			4	4	18
4 days	5	0			4	5	12
5 days	4	17				7	11
6 days	3	9				5	15
7 days	3	7			1	6	11
8 days	5	5				6	8
9 days	9	5			1	2	11
10 days	10	3					4
11 days	13	7				2	3
12 days	20	4				1	6
13 days	14	4				2	1
14 days	11	3				3	7
15 days	20					3	6
16 days	17						5
17 days	16						5
18 days	9	1				1	3
19 days	18	1				1	2
20 days	19					1	
21 days	61	2		2		2	2
22 days	28					2	
23 days	17		3	1			2
24 days	9	1					
25 days	5		4				
26 days	5	1	4	1		2	
27 days	4		2			1	
28 days	2			2			
29 days	2		2				1
30 days	3		1				
31 days	2		5	1			
32 days	1		1	1			
33 days	2		2				
34 days							
35 days	1		2			1	
36 days	1		1				
37 days			4				
38 days			2			1	
39 days	1		1				
40 days							
41 days							
42 days	1						
43 days				1			
44 days		1		1			
45 days							
46 days	1		1				
47 days							
48 days							
49 days							
50 days				1			
51 days					1		
52 days			1				
53 days				1			
54 days							
55 days				1			
56 days	1		2			1	
57 days			1				
58 days			1				
59 days							
60 days							
Total	353	555	48	14	23	60	147

TABLE X—COMPLICATIONS

	Lived	Died	Total
Appendicular			
Fracture radius	4	1	5
Fracture ulna	4	1	5
Fracture humerus	5	6	11
Fracture femur	1	7	8
Fracture tibia	8	8	16
Fracture fibula	3	5	8
Fracture patella	3	1	4
Fracture malleolus	2	2	2
Fracture ankle	0	1	1
Fracture hand	1	0	1
Fracture foot	3	0	3
Axial			
Fracture clavicle	23	8	31
Fracture scapula	3	0	3
Fracture vertebra	1	5	6
Fracture pelvis	0	3	3
Fracture ribs	1	5	6
Fracture acromion	1	0	1
Fracture sternum	0	3	3
Face			
Fracture nasal bones	0	0	0
Fracture through orbit	6	11	17
Fracture hard palate	0	2	2
Fracture mandible	1	3	4
Fracture zygoma	2	2	4
Fracture maxilla	3	0	3
Fracture molar	1	1	2
Fracture orbital plate with laceration of d. nerve		0	0
Alcoholism	184	127	311
Shock	60	51	111
Brain abscess	0	3	3
Bullet wound	0	1	1
Pulmonary edema	1	28	29
Pneumonia	2	70	72
Aspiration of blood into lungs	0	2	2
Hemothorax	0	2	2
Bronchitis	2	0	2
Fibrinous pleurisy	0	2	2
Emphysema	1	2	3
Fibroid phthisis	1	0	1
Acute suppurative meningitis	0	14	14
Cellulitis of scalp or face	2	0	2
Cellulitis regions other than head	1	0	1
Erysipelas of scalp or face	4	2	6
Erysipelas regions other than head	0	1	1
Lacerated wound of head infected	6	1	7
Otitis media	3	1	4
Ruptured ear drum	6	5	11
Mastoiditis	2	0	2
Blindness due to trauma	2	0	2
Keratitis	1	0	1
Conjunctivitis	3	1	4
Abscess parotid region	1	0	1
Abscess cervical lymph nodes	2	0	2
Other infected foci	2	2	4
Contagious impetigo	1	0	1
Synovitis	1	0	1
Septicemia	0	1	1
Internal injuries	0	6	6
Ruptured diaphragm	0	1	1
Multiple injuries not otherwise described	2	6	8
Mental symptoms acute and persisting	8	1	9
Lateral sinus thrombosis (and jugular resection) after mastoidectomy	1	0	1
Abscess of scalp	1	0	1
Gangrene of leg	0	2	2
Conditions existing previous to present illness			
Epilepsy	10	1	11
Heart disease	6	4	10
Lues	9	1	10
Tuberculosis	0	2	2
Arteriosclerosis	5	8	13
Hypertension	3	2	5
Hernia	3	0	3
Pregnancy	0	1	1
Paralysis agitans	1	0	1
Kidney condition	0	4	4
Liver condition	0	1	1
Arthritis	2	0	2
Encephalitis	0	1	1
Anterior poliomyelitis	1	0	1
Diabetes mellitus	0	1	1
Paralysis of arm with atrophy (following previous injury)	1	0	1

All patients with head injury should have X-ray films of the skull made in at least two positions (i.e. anteroposterior and lateral views).

Spinal fluid findings In 846 cases (of the 1,000 studied) lumbar punctures were done and reports were made on the spinal fluid. These have been tabulated in relation with reported time periods of unconsciousness and mortality (Table VI). From this it is clear that the longer the period of unconsciousness, the poorer is the prognosis as regards life. Of 791 cases in which the spinal fluid was bloody, 393 lived and 499 died. Many patients died before lumbar puncture was performed (154).

Postmortem findings The postmortem findings by the New York City Medical Examiners have been tabulated according to the plan outlined by Dr B. M. Vance.¹ Of the 378 patients dying because of head injury autopsy examinations were made in 357. Of these 96.9 per cent showed fracture of the skull and 91.8 per cent showed laceration of the brain.

Bleeding from orifices Bleeding from the ears, nose, mouth, or about the eyes occurred in 701 of the cases. An analysis of the sites of hemorrhage is given here.

Time in the hospital. The attached grouping of the patients' time in Bellevue Hospital, correlated with the ultimate result and the presence of complications, is most interesting. Of the 378 patients who died, 201 passed away within the first 24 hours in the hospital—this argues for early medical therapy. In this series all patients operated upon within the first 10 days following injury died. (Cases with obvious subdural hematomas, operated upon, are not included in this series.)

Complications It is sufficient here to give a listing of the recorded complicating conditions. Alcoholism is very frequent, having been present in 311 cases. Pneumonia occurred in 72 cases, and 70 died. Meningitis (acute suppurative) occurred in 14 cases all succumbed. Brain abscess occurred in only 3 cases and was fatal.

TABLE XI.—NEURAL FINDINGS

Cranial Nerves		Cases
Abnormal		76
Coma		194
Conjunctiva		22
Facial nerve (dysfunction, paralysis, etc.)		294
Hyperventilation		27
Respiratory		175
Normal		
Dead on admission		—
Not recorded		—
Total		1000

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TABLE VI.—NEURAL FINDINGS (Continued)

Cranial Nerves				
I Nerve	Only cases	its recorded involvement		
II Nerve				
		Re-	Right	Left
		ferred		
Comparison of the discs		71	3	5
Papilloedema		20	4	
Hemorrhage				
Normal				128
Not observed (not recorded)				128
Left hemiparesis or died before admission				25
Total		96	9	133
II Nerve involvement of the 230 cases observed				
Comparison of the discs				22 per cent
Papilloedema				6 per cent
Hemorrhage				8 per cent
Normal				54 per cent
III, IV, VI Nerves				
III Nerve				
Displaced				100
Contracted				86
Right greater than left				128
Left greater than right				99
Unusual				200
Normal				128
Not observed				
IV Nerve				
Displaced				128
Contracted				128
Normal				200
Not observed				200
VI Nerve				
Displaced				2
Contracted				7
Left internal strabismus				4
Right internal strabismus				7
Left external strabismus				1
Right external strabismus				1
Conjunctiva movement to left				12
Conjunctiva movement to right				1
Conjunctiva movement upward				1
Left strabismus (?)				20
Strabismus				
Slow deviation				12
Mydriasis—spontaneous lateral				1
Mydriasis—spontaneous to right				1
Mydriasis—spontaneous to left				1
Vertical strabismus				20
Cycloplegia unilaterally present				20
Excess strabismus				6
Phos—light				12
Phos—dark				12
Exophthalmos or endophthalmos				
Total strabismus				
Left eye, no movement				
Control side				
V Nerve				
Motor				
Right				
Left				
Sensory				
Right				
Left				
VII Nerve				
Posterior nerve paralysis (decreased)				
Right				22
Left				22
Supranuclear focal weakness associated with homophagia on same side				
Right				24
Left				24

TABLE XI—NEURAL FINDINGS (Continued)

VIII Nerve						Gait impaired		Co-ordination		
Deafness						Falling to left (residuum)				
Right						15		Finger to nose and heel to knee—no observations made		
Left						18				
Bilateral						1		Speech		
Weber, referred to								Motor aphasia		13
Right						4		Sensory aphasia		2
Left						6		Stuttering (?)		1
								(No observations made in most cases)		
Runné								Reflexes		
Right						4		Deep reflexes		
Left						4		Changed		588
Bilateral						1		Normal		222
Tinnitus								Not recorded		100
Right						2		Number of cases recorded		810
Left						1		Percentage of recorded cases with changes in deep reflexes		
Bilateral						6				72·6 per cent
IX Nerve								Superficial reflexes		
No recorded involvement								Changed		~35
X Nerve								Normal		211
Inability to swallow						1		Unrecorded		354
XI Nerve								Number of cases recorded		636
No recorded involvement.								Percentage of recorded cases with changes in superficial reflexes		67·3 per cent
XII Nerve								Sensory		
Tongue deviation to								29 cases of the 1000 fractured skulls showed sensory changes.		
Right						7				
Left						7				
								Abnormal Involuntary Movements		
Motor palsies—W weakness, paresis P paralysis, S, spasticity F, flaccidity								Opisthotonus		1
Monoplegias								Convulsions		
Arm Right						W 6 P 1 S 5 F 2		General		81
						14		Focal		34
Left						W 3 P 3 S 6 F 1		Athetosis		1
						13		Tremor		
								General		2
								Focal		23
Leg Right						W 1 P 0 S 3 F 0		Twitches		
						4		General		2
								Focal		4
Left						W 2 P 0 S 3 F 0		Total		148
						5				
Hemiplegias										
Right arm and leg						W 11 P 5 S 5 F 3				
						24				
Left arm and leg						W 6 P 3 S 6 F 2				
						17				
Paraplegias (both legs)						W 0 P 1 S 8 F 3				
						2				
Quadriplegias						W 4 P 2 S 35 F 36				
						35		Probably mostly alternating phases of decerebration		
Decerebrate fits (alternating flaccid and spastic states)						36				
Summary										
Total number of cases with motor palsy						171				
Negative (no abnormal motor signs)						315				
No observations of motor status recorded						514				
Total						1000				
Of 486 cases with observations of motor status										
35·2 per cent showed motor palsy										
64·8 per cent were negative.										

TABLE XII.—TREATMENT (Continued)

Cardiac			
Digitalis	29	41	
Glucose			
Scrophularia	1	1	
Gastro-intestinal			
Khler's and soda	14	14	
Food, in apt	4	3	
Lactogen's gastric sedative			
Mucous oil			
Old rice	6	6	
Cream oil			
Respiratory			
Oxygen			
Artificial respiration			
Alpine lobelia			
Anti-toxic			
Mixed treatment		4	
Miscellaneous			
Alcohol	22	71	84
Adrenalin		49	100
Peppermint		1	2
Saline dyes	22	46	79
Glucose sedative		27	46
Gastro-lysis		20	22
Spontaneous fracture	20		12
Acetyl salicylate			
Styrene	8		
Diuretic			
Glycerin	3		5
Glycerin			5
Tonic, iron, calcium, strychnine			5
Restorative spinal tap			4
Peppermint	5		
General shock			
Glucose's vaccine			
Organic anisole			
Mixed treatment			
Phosphorus			
Ammonium chloride			
Therapy	3	7	

Treatment and operations. Treatment in this group was found to be most varied. The listing includes therapy directed both toward the acute phase following injury and for underlying or associated existent complications. It should here be pointed out that this material represents hospital admissions during the years 1926 to 1929. Since that time the routine "skull case" treatment has included administration of hypertonic glucose by vein to all patients.

Surgical operations on the skull were performed in 37 cases (including one simple trephine) of these 14 lived and 23 died.

CONCLUSIONS

This study reveals the frequency of central nervous system involvement complicating acute head injury. It is statistically proved that conservative management of this group of cases is indicated.

TABLE XIII.—OPERATIONS

Type	Case
Trephine	
Sub-temporal decompression	
Right	8
Left	14
Both sides	
Side not given	3
Total	30
Osteoplastic flap	6
Sub-occipital decompression	
Total number of operations	37

*Of these 6 had depressed fractures.

A simple plan of treatment has been described in part elsewhere¹ and consists of the following steps:

1. Treatment of shock by the intravenous injection of 100 cubic centimeters of 50 per cent hypertonic glucose solution.

2. Lumbar puncture for diagnosis and treatment.

3. Repetition of hypertonic dextrose by vein to reduce increased intracranial pressure (100 cubic centimeters of 50 per cent solution 3 times daily).

4. Injection of caffeine sodiobenzoate, $\frac{3}{4}$ grains (0.5 grams) every 4 hours (hypodermically).

5. Rectal taps of 25 per cent solution of dextrose 4 ounces (120 cubic centimeters) every 4 hours.

6. Elevation of head of bed 15 to 45 degrees.

7. The carrying out of operative procedures indicated in compound fractures which require débridement and in cases suspected of progressive middle meningeal hemorrhage.

8. The use of antimeningococcus serum in suitable cases.

9. The performance of right subtemporal decompressions in comatose patients with marked papilloedema, who do not respond to the above mentioned procedures within 3 hours.

10. Uncomplicated depressed skull fractures may be elevated after the acute stage of shock has passed. Surgical interference in this group may often be safely postponed for many days.

With me express our thanks to the directors of the Fox Surgical Division at Bellevue Hospital for their courtesy in permitting us the use of this material and to Miss Sarah P. Stone for her untiring industry with these records.

Forster Kennedy and E. Bernard Wertz. J. Am. M. Ass. 1934, 30, 1, 144.

SUNLIGHT IN SURGERY

FRANK P CORRIGAN, M D , AND WILLIAM BOUKALIK, M D , CLEVELAND, OHIO
From the Surgical Service of St. Alexis Hospital

THE value of strong natural sunlight in the prevention of infection and treatment of wounds was first called to attention while practicing in the Atacama desert which makes up the greater part of the Province of Antofagasta in Northern Chile

This is a region of very intense sunlight and practically no rain—drier even than the better known Sahara desert. The amount of sunshine in this part of the Chilean Pampa from the Pacific Ocean to the west ranges of the Andes Mountains is an almost constant quantity. In all seasons it can be depended upon with almost absolute certainty. Expensive equipment was therefore not necessary in order to take advantage of its therapeutic benefits. It became our custom to expose badly mangled hands, arms, and legs to the sterilizing influence of the ultraviolet rays contained in this hot, white sunlight. The effects were so unmistakable as to leave no room for doubt. The devitalized tissues of the wounded members became mummified. Débridement operation could be done later under the guidance of an absolute line of demarcation. No other method of antiseptic treatment, in my experience, has been anything like as effective or as satisfactory as this simple and inexpensive use of natural sunlight. However, its use is not general even in this region and little has been noted of its beneficial effect.

A few years later while visiting in Quito, the capital of the Republic of Ecuador, we learned something more about the use of sunlight from Dr. Isidro Ayora, later the distinguished president of that country, and his notable colleague, Dr. Villavicencio Ponce. These able surgeons had a keen appreciation of the value of natural sunlight. They had arranged circular plantings of shrubs in the grounds surrounding their clinic. There was an opening through which the bed of the patient could be passed. The interior of this green circle formed a cubicle in which the patient could lie naked with the whole body exposed to the healing rays of the equatorial sun. They explained that they had been using the sun rays very much as the writer and his predecessor, Dr. William F. Shaw, now of Mexico City, had been using them in the Chilean desert. They considered it the most effective treatment for the superficial lesions of leprosy, a disease unfortunately only too common in that region. They observed

that it was even more effective than the vaunted chaulmoogra oil treatment.

Although the vogue of sun bathing has begun to spread, it is remarkable how little the sun rays have been used in this country and it is still difficult to get a real open-air sun bath even in the summer time, the only season when the ultraviolet content would be strong enough to be effective in the northern latitudes. In places where the sun is a more dependable agent such as Miami Beach, Florida, a real interest in this subject has begun to develop and some valuable studies are now being made by O. J. Seitlein at the St. Francis Hospital and at the laboratory established at the University of Miami through the vision and generosity of Dr. Thompson.

In the North, especially in the large cities, it is still a difficult matter to obtain a location and privacy where real sunlight exposure of the whole body is available.

While not minimizing excellent results and benefits to be obtained by intelligent use of the various sources of ultraviolet rays that are available, it has always been a source of regret that the beneficial rays of natural sunlight are not more extensively used.

The more powerful therapeutic lamps may be a source of considerable mischief in untrained hands, their use must be intelligently supervised. Recently there has come to our attention, a lamp which approximates natural sunlight so closely that it may really be considered an effective substitute. It has the further merits of being almost if not entirely free from danger in general use by nurses or orderlies in the wards of the hospitals. The lamp devised by Dr. Matt Luckiesh and his associates, in the research laboratory of one of the great electrical associations, consists of a heavy tungsten filament in a bulb of special glass with a button of quicksilver which volatilizes. The volatilized mercury then shortcircuits the tungsten filament producing a mercury arc which emits practically the spectrum of the mid-day summer sun, including its ultraviolet content.

The technical description, which shows how by screening, changing voltage, etc., the emanation may be moved up and down on the spectral ladder to whatever level is required, is not properly a part of this paper. The diagram better illustrates the spectral level of optimal benefit (Fig. 1).

TABLE XII—TREATMENT (Continued)

Cardiac		
Digitals	29	4
Glucose		
Strychnine	1	1
Gastro-intestinal		
Barbark and soda	10	16
Dosed in opia		1
Lactwood, gastric sedative		
Mineral oil		
Oil ricin	6	6
Croton oil		
Respiratory		
Oxygen		
Artificial respiration	4	
Alpha iodine		
Auto-haemic		
Mixed treatment	4	4
Miscellaneous		
Azophos	2	61
Adonisin	1	100
Aspirin	1	1
Barium chloride	46	79
Glucose-insulin	1	27
Quinine lysine	8	26
Serum lysine	30	11
Acetyl salicylate	11	21
Barbitone	1	1
Dakin's		
Lanolin	1	1
Glycerin	1	1
Tannic, iron, opium, strychnine		
Metastatic ricin top		
Polysomnol	1	6
Insulin drink		
Swensen's vaccine		
Corrosive sublimate		
Blind treatment		
Phlebostomy		
Ammonium chloride		
Phosphorus	1	

Treatment and operations Treatment in this group was found to be most varied. The listing includes therapy directed both toward the acute phase following injury and for underlying or associated existent complications. It should here be pointed out that this material represents hospital admissions during the years 1926 to 1929. Since that time the routine skull case treatment has included administration of hypertonic glucose by vein to all patients.

Surgical operations on the skull were performed in 37 cases (including one simple trephine) of these 14 lived and 23 died.

CONCLUSIONS

This study reveals the frequency of central nervous system involvement complicating acute head injury. It is statistically proved that conservative management of this group of cases is indicated.

TABLE XIII.—OPERATIONS

Type	Case
Trephine	
Sub temporal decompression	
Right	1
Left	4
Both sides	1
Side not given	1
Total	7
Osteoplastic flap	6
Sub-occipital decompression	
Total number of operations	17
*Of these 6 had depressed fractures.	

A simple plan of treatment has been described in part elsewhere¹ and consists of the following steps:

1. Treatment of shock by the intravenous injection of 100 cubic centimeters of 50 per cent hypertonic glucose solution.

2. Lumbar puncture for diagnosis and treatment.

3. Repetition of hypertonic dextrose by vein to reduce increased intracranial pressure (100 cubic centimeters of 50 per cent solution, 3 times daily).

4. Injection of caffeine sodiobenzoate, $\frac{1}{15}$ grains (0.5 grams) every 4 hours (hypodermically).

5. Rectal taps of 25 per cent solution of dextrose, 4 ounces (120 cubic centimeters) every 4 hours.

6. Elevation of head of bed 15 to 45 degrees.

7. The carrying out of operative procedures indicated in compound fractures which require débridement, and in cases suspected of progressive middle meningeal hemorrhage.

8. The use of antimeningococcus serum in suitable cases.

9. The performance of right subtemporal decompressions in comatose patients with marked papilloedema who do not respond to the aforementioned procedures within 3 hours.

10. Uncomplicated depressed skull fractures may be elevated after the acute stage of shock has passed. Surgical interference in this group may often be safely postponed for many days.

We wish to express our thanks to the directors of the Four Surgical Divisions at Bellevue Hospital for their courtesy in permitting us the use of this material, and to Miss Sarah P. Skura for her untiring industry with these records.

Forster Kennedy and S. Bernard Werts. *J. Am. M. Ass.* 1931, 100, 1, 101.



Fig 2 Illustration shows the lamp in use in infected compound fracture.



Fig 3 Sun lamp—initial treatment given 24 hours after perineorrhaphy

cal case of the type to which we have been referring but we relate it because of the lesson it teaches, namely, that occasionally a patient's skin is extremely sensitive to the ultraviolet rays

The results of the study of the grades of pigmentation in the normal skin, which is being made by Dr Thompson, at Miami Beach, will be very useful in enabling us to avoid such unpleasant experiences

The lamp had its most spectacular and beneficial effect in a case of tuberculous peritonitis. Very often after operation in such cases the wound fails to heal or a sinus forms. In our case the lamp was used immediately and prompt healing of the wound followed, no sinus formed and apparently the lamp had a beneficial effect upon the peritonitis. In this case the lamp was continued for a period of 4 weeks. When its use was discontinued the abdominal wall was tanned to a dark, almost chocolate, brown color, but the patient had never experienced any discomfort.

This paper, based on limited clinical observation, is issued as a preliminary report with the hope of stimulating further observation and the use of this therapeutic agency in purely surgical conditions. We are absolutely convinced that it has definite value as a prophylactic and bactericidal agent, and that we have by the invention of this lamp obtained a simple and inexpensive method of approximating the effects of natural sunlight. It is almost but not quite foolproof. The same thing can also be said with regard to natural sunlight itself. However, any intelligent nurse or orderly can be taught the safe use of this lamp after a very brief instruction. The lamps are portable and can be kept on the ward or in various parts of the hospital and applied very much as other routine procedures of nursing care.

We shall be interested in reading the experiences of other surgeons as we feel that there is a wide possibility for the use of this agency in our special field.

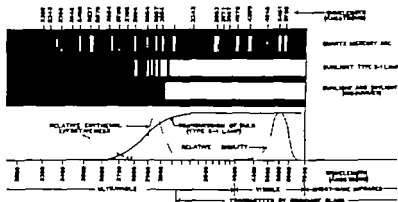


Fig. 1. Comparison of spectra of the quartz mercury arc, sunlight lamp, and mid-summer sunlight. The spectral regions of erythral effectiveness, ultraviolet radiation, visible radiation, and transmission of ordinary glass are shown.

During the past year we have had four of these lamps installed in the wards of St. Alexis Hospital and have made some clinical observations as to the uses to which this artificial sun might be put in the surgical field.

The devices are light and easily portable and we have had no trouble or difficulty in moving them around from one part of the hospital to another so that certain types of cases might be treated in which we wish to observe the effect of their use (Fig. 2).

We had been using the quartz light in certain selected cases, especially in plastic work as a prophylactic against infection and welcomed the opportunity to try this simpler and more foolproof device, especially as we felt that it more nearly approached the natural sunlight with which I had experience in South America.

There is a special difficulty in keeping certain types of surgical wounds free from infection. There are difficulties encountered in keeping certain skin areas sterile. This may be on account of their position as for example, the perineal region in the female. In the repair of a relaxed vaginal outlet, the area is moist, contamination is ever present, and resulting infection of the postoperative wound following perineorrhaphy for example, threatens the success of all plastic procedures in this region. In this type of case the "sun lamp" has been very beneficial. An application two or three times a day starting within 24 hours after operation, has kept the wound dry and inhibited the growth of bacteria. These wounds have done well under the treatment better than formerly. Whether this has been due only to a negative action in inhibiting growth of bacteria or whether there has also been a stimulating effect such as increased blood supply thus aiding repair is yet to be seen. At any rate,

it seems to have had its greatest value in such cases. The lamp has also been used on other surgical wounds, such as laparotomy wounds, slow healing, small plastic skin wounds, accidental lacerations, skin grafts. In all there have been about two hundred cases that have been partially treated with the lamp. By that is meant that all routine measures were used in addition to the lamp.

As a means of controlling infection, it has many advantages. It is clean, it does not stain, it is not greasy or sloppy and it is usually painless.

The method of using the lamp has been very simple. We have started exposure of the wound area with the bulb at a distance of about 30 inches, for 5 minutes as shown in the illustration (Fig. 3). This is repeated in 8 hours. Each succeeding day the time has been increased 1 or 2 minutes, depending upon the degree of pigmentation present in the skin. The distance is also gradually decreased but is never made less than 30 inches. No attempt has been made to protect the adjacent areas. They are exposed along with the area that is being treated. The ordinary reaction has been a very mild erythema on the first day with no subjective symptoms of burning or itching, followed by a light tanning after three or four days exposure. We have had only two unfavorable results from the use of the lamp. The first was a Reverdin pinch-graft on the thigh of a boy aged 7 years. These grafts had taken and were growing well, when, hoping to speed their growth the lamp was used in the usual manner with the result that the grafts sloughed off and it was necessary to apply other grafts. In another case—a very painful sprained shoulder—the lamp was used and produced a sedative effect, relieving the pain but producing a severe sunburn. This was not a surgi-



Fig 1



Fig 2

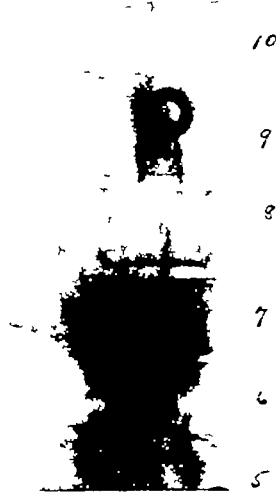


Fig 3

Fig 1 Sagittal view of the thoracic spine showing by stereoscope only the characteristic appearance of the body of the eighth vertebra upon which the diagnosis was based. This view shows a soft tissue shadow mainly to the left of this vertebra which was very confusing and which led to a suspicion of a cold abscess or large tumor such as sarcoma. The final identity of this shadow, however, was never determined.

Fig 2 Lateral view of the thoracic spine, showing the characteristic appearance of the body of the eighth vertebra which suggested the final diagnosis of hæmangioma. The

mottled appearance of this vertebra extends posterior into the lamina.

Fig 3 Sagittal roentgenogram of thoracic spine after injection of campidol (1.25 cubic centimeters) into spinal fluid needle being inserted between the third and fourth lumbar vertebrae. With the patient in the inverted position the campidol shadow is seen to be stopped at the level of the intervertebral space between the eighth and ninth thoracic vertebrae, indicating a block at this point. The metal identification marker is at the level of the body of the ninth vertebra.

A recent review of cavernous hæmangioma of the vertebræ by Bailey and Bucy included 11 cases of this type of lesion which had caused cord compression, and none of which were diagnosed correctly before operation. Four of them were operated upon and 2 survived, 1 of them being the case reported by Bailey and Bucy.

Our case presents several points of interest which makes it worthy of record. The condition was correctly diagnosed from the roentgenograms and the patient made a complete recovery following operation.

The roentgenologic features of hæmangioma of the vertebræ consist, according to Bailey and Bucy, of 'reduction in bone density between parallel vertical trabeculae which are increased in density.' Thus, they regarded as pathognomonic of angioma of the vertebræ. It was due to the signaling of these features by these authors, that a roentgenologic diagnosis of angioma of the vertebræ was made by one of us. It will be seen from the accompanying reproductions from the roentgenograms that the features as pointed out by Bailey and Bucy are well exemplified in our case. To the description of these authors we would add that there is an appearance of large vacuoles

due to the presence of large vascular channels in the bone, and which do not assume the locations or take the known courses of the normal vessels. This whole appearance is analogous or in a way similar to that found associated with cavernous hæmangiomata of the skull, described by Cushing and more in detail by Sosman as a typical honey-comb or network appearance. The reasons for these appearances in the vertebræ and the cranial bones are obvious.

Despite the roentgenological diagnosis in the case here reported there was some hesitancy about its acceptance clinically, because of the fact that the condition is as yet so little known and so rarely encountered. The diagnosis was fully confirmed, however, both at operation and histologically.

From the operative standpoint, our case represents the third which has been successfully treated surgically. The patient showed prompt improvement following operation, and 3 months later had completely recovered the power in her legs, and was entirely well.

There are some features of the clinical aspects of these tumors which deserve mention. Not all angiomas of the vertebræ cause compression of

HEMANGIOMA OF THE VERTEBRÆ

BERNARD J. ALPERS, M.D. AND HENRY K. PANCOAST, M.D. PHILADELPHIA

From the Neurosurgical Clinic and Laboratory of Dr. C. H. Frazer and the Department of Radiology of the Hospital of the University of Pennsylvania

HEMANGIOMA of the vertebrae is very uncommon. We have had occasion recently to see a case in which it was possible to make a pre-operative diagnosis from roentgenograms. The patient was successfully operated upon and was very much improved following operation.

**HEMANGIOMA OF EIGHTH THORACIC VERTEBRÆ
WITH SIGNS OF CORD COMPRESSION AND EVIDENCE OF COMPLETE SUBARACHNOID BLOCK.
TYPICAL ROENTGENOGRAPHIC APPEARANCE.
OPERATION FOLLOWED BY MARKED IMPROVEMENT**

The patient, Jewish woman, aged 46 years, was admitted to the service of Dr. W. G. Spiller in the Hospital of the University of Pennsylvania on December 1, 1930. She came in complaining of inability to walk, difficulty which was traced back to 1926 when following the death of her husband she became weak in her legs, and encountered difficulty in moving about as easily as formerly. Her weakness became gradually worse until about 3 weeks before admission, when she found she was unable to walk without assistance. For 3 weeks before admission she was unable to walk at all.

When examined on admission, the only positive findings were present in her nervous system. There was paralysis of the lower extremities, with signs of a level lesion extending to the eighth thoracic segment. The legs were utterly powerless and paralyzed. The right thigh seemed atrophic anteriorly especially in the region of the abductors. The patellar and Achilles reflexes were increased. There was Babinski on the right side but none on the left. Pain sensation was lost over both lower extremities to about the twelfth thoracic. Heat and cold were lost in the same area. Vibration was lost to the eighth thoracic vertebra.

Spinal puncture was done. There was an initial pressure of 4 millimeters of mercury, a level which did not change with compression of the jugular veins. There was evidence therefore of complete subarachnoid block, although the vagus sensory level would hardly have led one to expect it. There were lymphocytes in the spinal fluid and the Wassermann and colloidal gold were negative.

A roentgenological examination of the entire spine made December 7, 1930, showed a lesion involving the eighth thoracic vertebra. At first the appearance was interpreted as an irregular scottching involving the body and laminae. The sagittal view (Fig. 1) showed in addition very confusing soft tissue shadow medially to the left of this vertebra which suggested either neoplasm or cold abscess resulting from tuberculous disease. The final identity of this shadow was never determined. Further study of the appearance of this vertebra especially in the lateral view (Fig. 2) suggested that the appearance might be due to enlarged vessel channels in the bone, and one of us, having seen the original roentgenograms of Bailey and Gray's case, suggested the possibility of the lesion being hemangioma of the vertebra. A subsequent cannulation after cannuloid injection

between the third and fourth lumbar vertebra showed, with the patient in the inverted position, a complete block to the opaque fluid at the intervertebral space between the eighth and ninth vertebrae. It is quite significant that the operative notes on this case stated that there was not a suggestion of anything which could account for even partial block, much less complete one. This finding possibly may be explained by the fact that there had been lessening of symptoms between the times of examination and operation.

Because there was no clear cut sensory level, a cannuloid injection was made January 3, 1931, in view of the suspected spinal cord tumor. The iodized oil stopped definitely at the level of the intervertebral disk between the eighth and ninth thoracic vertebrae (Fig. 3).

The patient developed a retention of urine, but before operation she voided of her own accord and her legs became more mobile. There was no change in her sensory findings. A spinal puncture repeated at this stage demonstrated no subarachnoid block, but there were 30 lymphocytes in the spinal fluid. This partial resolution of pressure suggests that the case was regarded by Spiller as characteristic of hemangioma of the spine. It may also account for the fact that while the cannuloid roentgenographic study showed a definite block at the time, there was no evidence of block found at the time of operation, over 3 weeks later.

Operation. A decompressive laminectomy was performed by Dr. C. H. Frazer February 3, 1931, with the removal of the spinous processes of seventh, eighth, ninth, and tenth thoracic vertebrae. At operation it was noticed on separating the laminae that the bone was very much more vascular, softer and more cancellous than normal. This was especially true of the eighth and ninth thoracic vertebrae. Upon removal of the laminae, there was noticed between the laminae and the dura layer of highly vascularized tissue which appeared very much like granulations. Subtotal exploration was entirely negative and no evidence of block could be found. The patient made an excellent recovery following the operation, regained much power in her legs, lost her sensory disturbances, and was able to walk out of the hospital. Three months after her discharge she is seen in the follow-up clinic and was found to be entirely recovered. Her gait was perfectly normal, and she showed no evidence of either motor or sensory paralysis. Reoperation was instituted later in an attempt to prevent any further encroachment by the growth.

The microscopic picture showed typical hemangioma of the capillary and cavernous type (Fig. 4).

The tissue which was removed from the spinous process and laminae of the vertebra was composed of capillary and cavernous spaces lined with endothelium and often filled with blood. No myelogenous tissue was present. Among the blood spaces were numerous solid cords of tumor cells the structure of which was exactly similar to those lining the blood spaces. They were composed of oval or indented vesicular nuclei around which was an indistinct cytoplasm. Supporting the blood spaces was thin, delicate connective tissue stroma. In some parts of the tumor this connective tissue became very abundant and was found in broad sheets. Here and there small spicules of bone were found, without evidence of reaction within them. Reticulæ as present as delicate framework throughout the tumor.

FRACTURES OF THE WRIST

A REVIEW OF ONE HUNDRED SEVENTY-SIX CASES

RALPH K. GHORMLEY, M.D., F.A.C.S., ROCHESTER, MINNESOTA

Section on Orthopedic Surgery, The Mayo Clinic

AND

RUDOLPH J. MROZ, M.D., ROCHESTER, MINNESOTA

Fellow in Orthopedic Surgery, The Mayo Foundation

A REVIEW has been made of all fractures about the wrist seen at The Mayo Clinic in the period of 5 years ending July, 1930. We have included all "old" fractures, whether or not they were treated, and all "fresh," or acute, fractures treated. We have regarded as fresh fractures all of those seen within a period of 2 weeks of the inciting injury. The two groups offer an interesting parallel study and emphasize certain facts which would not be brought out in a study of either group alone. The series consists of 176 fractures, 87 fresh, and 89 old. As part of this study, we have gathered data on end-results concerning cases of acute fracture, so far as possible, and concerning cases of old fracture, if operative treatment was carried out. These studies of end-results are tabulated. In the majority of cases the roentgenograms have been reviewed and diagnosis verified. So far as possible pre-operative as well as postoperative roentgenograms were reviewed.

FRESH FRACTURES

In our grouping (Table I) we have not included all of the names sometimes used to designate these fractures, such as "Smith's," "Barton's," and so forth. But for its common usage and historical importance we might have omitted the term "Colles'" fracture and have substituted the term "suprastyloid," as suggested by Ehason. Actually, as has been frequently pointed out, Colles did not describe what is now commonly known as a Colles' fracture, but a fracture of both bones higher in the forearm. According to Davis, Colles, in his description published in 1814, placed the site of fracture $1\frac{1}{2}$ inches (4 centimeters) above the joint. The same author stated that the fracture had been described previously by Pouteau and Nélaton, in 1783, but that it was "largely due to Robert W. Smith's *Treatise on Fractures in the Vicinity of Joints*, Dublin, 1847, that the name 'Colles' has become generally accepted." Smith placed the fracture a quarter of an inch to 1 inch (0.5 centimeter to 2 centimeters) above the joint and this situation has been generally accepted by all authors since that time.

Colles' fractures In classifying the Colles fractures we have purposely omitted the term "impaction." In our experience, in the majority of these cases there is some impaction when the cases are first seen. The nature of the bone involved, and the mechanism of the fracture, make this usual. We have grouped these as comminuted or not comminuted, which seems to us far more important. This complication at once leads to modification of the prognosis and occasionally to modification of treatment. No doubt such a fracture as that known as Barton's does occur and was present in some of these cases, but to us its treatment and prognosis do not seem sufficiently distinctive to warrant separate classifications.

The most important point to note in the original roentgenogram, then, is the presence or absence of comminution. With comminution, particularly if it extends into the joint, breaking the articular surface, the prognosis at once must be a little more guarded than otherwise. Any injury to the articulating surface of the radius is bound to set up active traumatic arthritis in the radiocarpal joint. Comminution occurred in slightly less than half of our cases. It may have been present in a few of those in which it was not noted, and in which we were unable to review the original roentgenograms. Its presence in 50 per cent of the cases is, however, of much significance.

Fracture of the styloid process of the ulna is a second point of importance to note. In this series, it occurred in approximately 63 per cent of the cases. It should be noted for two reasons. First, no doubt it makes accurate reduction more difficult. Second, in many cases in which it is fractured, tenderness and swelling about it are the most persistent signs of disability. Other authors have reported that this complication is seen in from 40 to 50 per cent of Colles' fractures. Why the proportion should be higher in this series is not easily explained. There doubtless are many cases in which actual fracture of the styloid process of the ulna cannot be demonstrated in the roentgenogram, but a tear of the ulnar collateral ligament takes place. Injury to the distal radio-ulnar

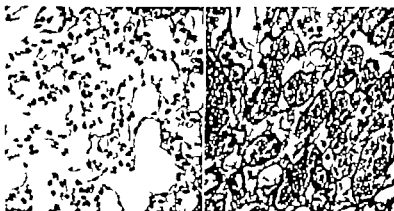


Fig. 4. Left, low power view of the tumor showing the numerous capillary and cavernous blood spaces lined with endothelium. Solid columns of endothelial cells are seen here and there in the tumor. Right, higher power view showing many of the spaces filled with blood.

the spinal cord. Those which do so produce their effects probably by extension of the tumor from the vertebra to the extradural area, thus causing cord compression without much narrowing of the lumen of the vertebral canal. In our case the latter was not narrowed to any appreciable extent as far as the naked eye could observe, but there was a definite extension of the tumor along the outer side of the dura. Incision of the latter showed no tumor tissue to be present subdurally. In the case of Bailey and Bucy, there was not only a marked narrowing of the spinal canal but the peridural tissue was found to be exceedingly vascular."

Furthermore, sensory levels in these cases seem to be notably vague and indefinite. This was so in our case, and seems to have been true of the other cases collected by Bailey and Bucy.

At one time a complete subarachnoid block was demonstrated in our case by Queckenstedt test but could not be confirmed on a second occasion. This suggests the possibility that there may be a certain amount of expansion of these tumors due to filling of the blood spaces, and that at such times the symptoms may be definitely aggravated. The course of our case would tend to confirm this view because there were periods during the course

of her illness in which she lost some of her symptoms and seemed to be almost in a remission. It is our belief that an increase and decrease in blood flow through the tumor expanding and collapsing the cavernous and capillary spaces, may account for the variations in symptoms, and for the appearance and disappearance of subarachnoid block.

CONCLUSIONS

1. A case of hemangioma of the vertebra is reported.
2. A pre-operative diagnosis was made by means of the characteristic roentgenographic appearance.
3. Operation was successful and the patient made a complete recovery.

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TABLE II—END-RESULTS IN ACUTE OR FRESH FRACTURE

Types of fracture	Total number of cases	Cases followed	Result			Cases not followed
			Good	Fair	Poor	
Comminuted Colles' with fracture of styloid process of ulna	19	14	11	3	0	5
Comminuted Colles' without fracture of styloid process of ulna	7	6	4	0	2	1
Colles' with fracture of styloid process of ulna	15	10	9	0	1	5
Colles' without fracture of styloid process of ulna	14	9	6	3	0	5
Styloid process of radius	8	8	6	2*	0	0
Epiphyseal separation	11	6	6	0	0	5
Greenstick and subperiosteal	5	2	2	0	0	3
Radius and ulna near wrist	3	2	0	2 (1 compound)	0	1
Navicular	4	3	3	0	0	1
Reverse Colles'	1†	1	0	1	0	0
Total	87	61	47	11	3	26
All cases (per cent of 87)			54	13	3	30
Cases followed (per cent of 61)			77	18	5	

*Styloid of radius scaphoid and dislocated capitate.
†Comminuted, compound fracture of navicular and fifth metacarpal.

see no reason for having trouble with the short anæsthesia by nitrous oxide gas and oxygen, or ethylene, necessary to accomplish reduction, particularly if skilled anæsthetists are available.

The type of fixation is worthy of some comment. Our choice is two splints of plaster of Paris, one on the dorsal aspect, running from the metacarpophalangeal joints to just below the elbow, the other on the palmar or volar aspect, running from the palm, at the metacarpophalangeal joints, to a point far enough below the elbow to allow free flexion of that joint. These should be applied with the hand pronated and the wrist palmar flexed, in some ulnar deviation. Properly applied splints allow free motion of the fingers, which should be encouraged at once, and the rolled edge of the palmar splint makes a good grip on which to exercise the fingers. In this way firm fixation of the wrist may be obtained without loss of movements of the finger. This is certainly the best position in which to maintain complete reduction of a Colles' fracture. In many cases, no doubt, it may be maintained with the wrist straight. Very little padding should be used between the skin and the plaster splints. If

the splints are carefully molded while the plaster is setting and held in place by gauze bandages no trouble will be encountered. The patient should be warned of the danger of swelling and should be seen at least once in 24 hours after reduction. It will usually be necessary to cut the bandage and reapply it, although occasionally the swelling is not enough to demand this. Cotton has advocated leaving the wrist in this position for 3 weeks. In our experience this is not necessary in the majority of cases. Seven to 10 days suffice to get firm enough fixation so that the flexed position can be abandoned for a straight or slightly dorsiflexed position, maintained preferably on an aluminum cock-up splint. For older persons, in whose cases comminution is marked, longer fixation is necessary. It must be borne in mind, however, that, in these cases of older persons, trouble from too long fixation in the flexed position may result.

With the change of position and of splint, active movement may be commenced. If physiotherapy is available, and if the patient can afford it, restoration can be hastened by daily baking, light massage, and active exercises. A few instructions to the patient for home use will help very much. Most patients can be trusted not to overdo active movements. They are the most essential part of the program of rehabilitation, and no patient need omit daily active movement after the original fixation splint is removed. Roentgenograms for re-examination should be taken at the end of 10 days or 2 weeks. If any loss of position has occurred it usually is possible to correct it at this time, whereas later it may be impossible without refracture or osteotomy. In treatment of younger persons, all splints can be abandoned in 3 to 4 weeks, for older persons 5 to 6 weeks should be all that is necessary.

In fractures of the styloid process of the radius, without displacement, a splint should be applied for relief of pain. Early, active movements should be possible within a week, and the splint should be abandoned in 2 to 3 weeks at the most.

Epiphyseal separation should be reduced at once, under anæsthesia. Splinting of the same type as that just described should be applied, and movement should be started in one week. All splints should be abandoned in 2 weeks. Greenstick and subperiosteal fractures should be treated approximately according to the same schedule.

Fracture of both bones near the wrist is an entirely different problem if displacement occurs. Often the only method of getting satisfactory reduction of these fractures is by open reduction,

joint must occur in many of these cases. Often definite separation or comminution of the ulnar border of the articulating surface of the radius is seen in the roentgenograms. All of these facts should be remembered and if it is possible to visualize the lesions, they should be noted. We have frequently noticed swelling and effusion along the flexor tendons. This would be expected and in our experience may nearly always be noted. It is apparently usually of no significance, but it may cause rather prolonged limitation of motion in the flexor tendons, and is particularly troublesome if patients are loath to use their fingers early in the treatment. It is no doubt a very important contributing factor in cases in which prolonged immobilization leads to prolonged disability.

Injury to the nerves in our series of cases was not common. Turner noted that injury to the ulnar nerve may occur as evidenced by excessive perspiration and hyperesthesia over the palmar side of the carpal bones, hyperesthesia of the thenar eminence, and pain over the distribution of the ulnar nerve, particularly if the ulnar styloid process is torn off. According to the same author the most serious change occurs in the dorsal interosseous nerve. He stated that this is evidenced by edema distal to the second phalanges of all four fingers, glossy and reddened skin, stiffness of the fingers, with limitation of active and passive motion, and osteoporosis. Exploration in these cases revealed a spindle shaped and congested nerve. These complications may be present more frequently than we have noted. We have not found them and we doubt their serious importance.

Fractures other than Colles. Fracture of the styloid process of the radius is seen more often in *backfire fractures*. It is less often displaced than any of the other fractures of the wrist. In two of our cases it was accompanied by fracture of the styloid process of the ulna, whereas, in another case, fracture of the navicular and capitate bones was seen complicating fracture of the styloid process of the radius.

Epiphyseal separations represent about 13 per cent of all the fresh fractures at the wrist. These are essentially the Colles fractures of children, although typical Colles fractures, too, may be seen in children. Greenstick fractures, and fractures of both bones of the forearm, near the wrist, are more often seen in children than in adults. An occasional subperiosteal fracture, near the joint, may be seen in adults, although it is a comparative rarity. In this group of acute fractures of the wrist, the navicular was the only carpal

TABLE I.—FRESH OR ACUTE FRACTURES

In the radius and ulna	
Colles'	28
Comminuted, with fracture of styloid process of ulna.	
Comminuted, without fracture of styloid process of ulna.	7
Not comminuted, with fracture of styloid process of ulna.	71
Not comminuted, without fracture of styloid process of ulna.	14
Reverse Colles (with fracture of scaphoid).	
Styloid process of radius (one with fracture of styloid process of ulna also; one with fracture of scaphoid and capitate).	4
Epiphyseal separations.	11
Greenstick and subperiosteal.	5
Both radius and ulna near wrist.	7
Carpal bones	
Scaphoid.	27
Trailed.	

bone of which fracture was noted. This is the carpal bone most commonly fractured, according to all series thus far published. No acute injuries to the semilunar bone were noted during this period.

Treatment of fresh fractures. The treatment of acute Colles' fractures has been described adequately many times. It may be summarized in three expressions: accurate reduction, adequate fixation, and early motion. If each of these requisites is followed, there will be few failures in the treatment of this injury. That many still are unsatisfactorily treated is sufficiently emphasized by the fact that in the period covered by this study we saw many cases of old Colles' fractures with unsatisfactory results.

In the first place, reduction must be accomplished. It is a very rare Colles' fracture that does not need some manipulation if uniformly good results are to be obtained. It is extremely rare, and perhaps impossible to have a Colles' fracture in which careful examination of the wrist and roentgenogram will not reveal some deformity. Slight deformities may be overlooked at the time of treatment, but they will not be overlooked by the patient later on. There undoubtedly are occasions and circumstances in which manipulation is contra-indicated, but we emphasize the fact that they are rare. In cases of fracture of the styloid of the radius, without displacement, manipulation is not needed. Greenstick and subperiosteal fractures can go without manipulation if there is no deformity or if the deformity is very slight.

The choice of anesthetic is important because anesthesia usually is necessary. Many advocates of local anesthesia are found today. If in their hands it is successful and their results justify its use, well and good. Our choice is general anesthesia. We have not had any trouble with it and

TABLE IV—OPERATIVE TREATMENT IN OLD CASES OF INJURY TO THE WRIST

Fracture	Operation	Cases	Result
Colles type	Osteotomy	4	Good 3 Fair 1
	Excision of distal end of ulna	2	Good 1 Undetermined 1
	Capsulotomy of fingers for stiffness	1	Good 1
Of navicular	Excision of proximal fragment	3	Good 3
	Excision of entire bone	1	Good 1
Of lunate	Excision	4	Good 2
			Fair 1 Poor 1
Of greater multangular	Excision	1	Fair 1

Operative treatment of old fractures A summary of those cases of old injury in which operation was performed here reveals the facts recorded in Table IV. In all other cases of injury to the carpal bones, physiotherapy was recommended. In one case there was septic infection and operation was contra-indicated. The results in the cases in which operation was performed are certainly good enough to justify more extensive trial of such a procedure. Osteotomy of the lower end of the radius, with or without the use of a bone graft to hold the fragments in their new position, when carefully done, can greatly improve the appearance of a deformed wrist. Excision of the lower end of the ulna, if it is prominent, and if the lower end projects downward beyond the line of the radiocarpal articulation is a simple procedure worthy of further trial. It not only improves the appearance of the wrist but often improves the function greatly. Excision of the proximal fragment of the navicular is fairly well established, as is excision of the lunate bone.

Backfire fractures There has been a great deal of attention paid to this type of fracture in the past 15 years. The importance of its mechanism

of production seems to us overemphasized. We found 19 fractures produced in this way: styloid process of radius, 6; Colles' with fracture of ulnar styloid, 6; epiphyseal separation, 4; subperiosteal, 1; and 2 of which the type was not noted. Fracture of the styloid of the radius is relatively higher in frequency in this group, 6 out of 8 of such fractures were produced in this manner. Edwards has elaborated on the mechanism and classification of these fractures. Other authors stress their importance. Our feeling is that with the passing of hand cranking automobiles they are probably going to be fewer in number, and consequently of less importance.

SUMMARY AND CONCLUSIONS

We have tabulated a group of fresh or acute fractures, together with a group of old fractures about the wrist. The importance of accurate reduction has been emphasized, together with early motion. Studies of end-results in acute cases, as well as study of old cases shows a relatively higher percentage of poor results in the simpler types of fracture, probably because the tendency is to let them go without reduction under anaesthesia. We have tabulated a small group of results in old cases treated by operation, and can recommend further use of these operative procedures.

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after which splinting in a straight position either with plaster or with plaster on board splints should be carried out. Such splints should be left on 2 to 3 weeks before movement is started depending on the age of the patient and the type of internal fixation if any that is used.

In fractures of the navicular reduction can be accomplished by manipulation and the fragments are best held in position by dorsal flexion with some radial deviation of the wrist. In cases in which fracture of the navicular is complicated by fracture of the styloid process of the radius, or by a Colles' fracture one must choose between accurate fixation of the radius or of the navicular. The former is probably more important, and the position of choice would be the straight or slightly palmar flexed wrist. It is apparently generally agreed by all authors that prolonged fixation of 4 to 6 weeks at least is necessary in fractures of the navicular.

Follow-up study Any method of follow up study is at best not perfect. Ours has been carried on, in so far as possible, by personal examination and by letter of inquiry. Response has been at least as good as the average as Table II will show. We have stated results as good, fair, and poor. Results were considered to be good if deformity was minimal or absent, and if there was normal range of motion, without pain. Results were graded fair if deformity existed which bothered the patient and if motion was limited, with or without pain. Results were considered to be poor if there was decided deformity with or without limitation of motion, and with or without pain. Personal examination is by far the most satisfactory type of follow-up.

We would like to call attention to the fact that the percentage of good results was higher in the more severe types of Colles fracture that is, those with fracture of the styloid process of the radius. This probably means that reduction was carried out, and not simply splinting without reduction which is always the temptation if slight deformity occurs.

OLD FRACTURES

This group, as we already have stated, includes all cases in which the injuries had existed 3 weeks or more. The time since injury ranged from 3 weeks to 7 years. Many of the patients were advised to have treatment, if necessary many were reassured some came obviously trying to make trouble for some physician with whose results they felt dissatisfied, but in most instances the poor results were due to the patient's own lack of co-operation. Studies of end results were

TABLE III.—CASES OF OLD INJURY TO THE WRIST (MORE THAN TWO WEEKS SINCE THE INJURY)

Radius and ulna	
Colles' fracture	5
With fracture of styloid process of ulna (see below)	
Isolated	11
Simple Colles'	
Comminuted Colles' with fracture of styloid process of ulna (in three cases there was associated fracture of the scaphoid)	12
Scaphoid Colles' fracture	
Fracture of styloid process of radius	
Fracture of styloid process of ulna...	
Metacarpal fracture	
Fracture of radius and ulna, bones just above wrist	
Carpal bones	
Injury to scaphoid (two lateral, one distal)	11
Injury to lunate (three with fracture of styloid process of radius, three distal; three isolated)	
Fracture of greater multangular (one with fracture of base of first metacarpal)	1
Total	40

carried out only in those cases in which surgical procedures were adopted at the clinic (Table III).

Colles' fractures In studying the cases of old Colles' fractures it was attempted to discover in so far as possible, the causes of complaint which brought the patients to consultation. Deformity with or without pain was noted in 30 cases; stiffness of less than 3 months duration in 6 cases; stiffness of more than 3 months duration in 13 cases and, concerning 5 cases the complaint was not stated. Deformity and stiffness were the most important complaints. Pain was nearly always present to some degree in the presence of one or another of these complaints. The reason for deformity is obviously inadequate reduction, and when one notes that anesthesia was used for reduction of only 3 of these 40 fractures the answer is plain. Stiffness, in cases of less than 3 months duration may readily work out to a satisfactory end-result. In other cases it is almost invariably due to too long fixation in plaster or splint. In some cases it is no doubt due to lack of co-operation on the part of the patient. In one instance a large damage suit was pending, and the case hinged largely on the stiffness. How could the joint be otherwise than stiff? The importance of physiotherapy can be emphasized here again. It was the only treatment recommended in most of these cases and had obviously been neglected in many. The fact is worthy of note that the non-communited fracture predominates in numbers in this series. This is probably due to the fact that these do not appear at first to be so severe and the temptation to let them go without reduction is often the reason for an inadequate reduction and therefore an unsatisfactory result.

TABLE IV—OPERATIVE TREATMENT IN OLD CASES OF INJURY TO THE WRIST

Fracture	Operation	Cases	Result
Colles' type	Osteotomy	4	Good 3 Fair 1
	Excision of distal end of ulna	2	Good 1 Undetermined 1
	Capsulotomy of fingers for stiffness	1	Good 1
Of navicular	Excision of proximal fragment	3	Good 3
	Excision of entire bone	1	Good 1
Of lunate	Excision	4	Good 2 Fair 1 Poor 1
Of greater multangular	Excision	1	Fair 1

Operative treatment of old fractures A summary of those cases of old injury in which operation was performed here reveals the facts recorded in Table IV. In all other cases of injury to the carpal bones, physiotherapy was recommended. In one case there was septic infection and operation was contra-indicated. The results in the cases in which operation was performed are certainly good enough to justify more extensive trial of such a procedure. Osteotomy of the lower end of the radius, with or without the use of a bone graft to hold the fragments in their new position, when carefully done, can greatly improve the appearance of a deformed wrist. Excision of the lower end of the ulna, if it is prominent, and if the lower end projects downward beyond the line of the radiocarpal articulation is a simple procedure worthy of further trial. It not only improves the appearance of the wrist but often improves the function greatly. Excision of the proximal fragment of the navicular is fairly well established, as is excision of the lunate bone.

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EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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ALLAN B. KARAVEL, M.D.
LOYAL DAVIS, M.D.

Managing Editor
Associate Editor
Assistant Editor

DONALD C. BALFOUR, M.D. Associate, Editorial Staff

SEPTEMBER, 1932

THE IMPORTANCE OF CLINICAL DIAGNOSIS IN SURGICAL CONDITIONS OF ABDOMEN

IN the early days of surgical operations in the abdomen methods of diagnosis had not been brought to a high pitch of accuracy. Even when an operative incision was made and the condition was under the eye many times it was difficult to make a diagnosis which satisfied us that the condition which we had diagnosed, and perhaps had found was sufficient to account for the patient's symptoms. Therefore, it was often almost a necessity at operation to make extensive examinations of all the abdominal viscera and sometimes to perform operations on organs other than the one primarily concerned.

In the course of time, as experience improved our diagnostic methods and gave us a clearer understanding of the causes of disease we were better able to recognize disease conditions found at operation and relate them to the patient's symptoms, and knew that cure or relief would result from surgical intervention. We could not quite rid ourselves, however, of the habit of performing secondary

operations for conditions of relatively little importance of which the patient had not complained. For example, when hysterectomy is performed for fibromyoma, the appendix is removed for cause, but formerly it was not unusual if gall stones were found to be present, to remove them at the one operation if quite proper if the patient's condition warranted it.

But with increased experience, we grew more and more cautious about performing operations of doubtful necessity when operating for serious conditions, unless the state of the patient rendered it safe. We were careful to examine the whole abdomen with the gloved hand for evidences of pathological conditions but we were increasingly conservative in operating as a routine for unimportant abnormalities.

When adequate pathological change is found to explain the symptoms for which the patient comes for relief the making of larger incisions and more extensive explorations in the presence of a serious major condition either because of the existing disease or because the patient is in poor condition is not wise.

In my operative work if I made no general abdominal exploration, I always told the patient and the family and gave the reason why. If it became necessary later to remove a diseased appendix, the patient and his family understood the matter. Again occasionally finding gall stones which probably would give trouble, I explained in each case to the patient and the family that it might be wise to remove the stones when convalescence from the immediate operation was well advanced and while the patient was still in the hospital.

At least I took pains that the persons concerned should be informed that gall stones were present, or that the appendix was or was not removed. In no instance that I can recall was the patient dissatisfied after such an explanation had been made.

The value of giving information of this sort at the time of operation is evident in connection with a subsequent illness of the patient, perhaps many years later. If the patient knows, for instance, that the appendix was or was not removed, the knowledge often saves the consulting physician and the patient the inconvenience and perhaps dangerous delay of waiting for information. In other words the patient should be informed regarding the whys and wherefores of those minor conditions which so frequently are found in connection with a major operation.

In this connection my whole experience leads me to believe that the clinical examination with the history of the patient is most important. The evidence given by the X-ray and other precise means of examination is so extraordinarily good that one sometimes leans too strongly on these aids. Recently a distinguished internist contrasted our present-day diagnostic methods with the old, showing that before the X-ray played so great a part in the diagnosis of disease of the gall bladder as it does today, the clinical diagnosis was 90 per cent correct. Since the X-ray has been used to make the diagnosis rather than to confirm it, diagnoses of gall bladder trouble are only 70 per cent correct, the disease being overlooked. This loss in accuracy applies also to diagnosis of ulcer of the posterior wall of the duodenum and of the stomach. The X-ray will be correct in about 95 per cent of cases of ulcer, but in at least 5 per cent it may be misleading. We should remember that the X-ray film gives a picture of the shadow of the object, and not a photograph of the ob-

ject itself. In the gall bladder, for instance, papillomata and cholesterosis may not produce X-ray evidence that stands out, and yet the disability and dangers for the patient are the same as if stones existed.

The corollary of my argument would be that the surgeon should not pay too much attention to the spectators in the seats or to what they may be thinking, but should give his undivided attention to the patient and to the patient alone. In major operations for serious conditions, any additional procedures should be considered very carefully lest they unnecessarily jeopardize a patient already seriously ill. Again, the laboratories should be used for the purpose of aiding the clinical diagnosis, but should not supersede it.

W. J. MAYO

LETHAL FACTORS IN INTESTINAL OBSTRUCTION

MUCH effort has been expended to determine the cause of death in acute intestinal obstruction with the ultimate hope that something might be found to aid in reducing the very high mortality incident to this disease. It is quite to be expected that such an intricate problem would call forth many theories, some of which border on the fantastic. Attention has been chiefly centered upon the content of the obstructed gut in an effort to explain the development and absorption of a toxin. Any theory based upon the absorption of pathological products developed within the obstructed bowel to date have fallen short of an adequate explanation of the symptomatology and pathology of the disease.

In recent years the subject has been approached from the standpoint of perverted physiology and alteration of the chemical balance of the body. Much experimental evidence has accumulated which shows the

importance of a loss of upper intestinal tract secretions. A complete drainage of the stomach will cause death. A complete drainage of the pancreatic juice will cause death. Complete drainage of the duodenum or upper jejunum will cause death. There is, therefore, abundant evidence that a loss of the upper gastro-intestinal tract secretions will result fatally. A loss of these secretions by jejunostomy causes changes in the blood chemistry similar to those found in high intestinal occlusion. The old idea that the content of an obstructed gut, when released into the normal gut below will produce death, has definitely been found to be erroneous. In fact quite the opposite has been proved true. The life of animals may be prolonged by deliberately injecting the stagnated content from above an obstruction into the normal bowel below. Substances accumulate in the obstructed gut which are essential to life. Toxic substances, such as histamin injected into an obstructed bowel are not absorbed. It, therefore, seems clear that toxic contents of an obstructed bowel are not absorbed producing the so called toxemia of intestinal obstruction.

Typical changes in the blood chemistry occur in high bowel occlusion, the most striking of which is the diminution in chlorides. There is also a rise in the non-protein and urea nitrogen and a rise in the carbon dioxide combining power of the plasma. In addition to these easily demonstrated changes, there is an increase in the total protein fibrin viscosity sedimentation rate, coagulability and a decrease in the oxygen

capacity. These changes indicate a marked disturbance of the physicochemical properties of the blood, probably very largely due to liquid loss.

Marked dehydration results from a loss of upper alimentary tract secretions. Dehydration experimentally produced, causes an increase in the nitrogenous elements of the blood, indicating a disintegration of protein tissue. This change is not unlike that produced by obstructive lesions of the small bowel. It is possible that the increase in non protein and urea nitrogen in the latter may be the result of a rapidly developing dehydration due to vomiting or accumulation of liquid in the stomach or obstructed bowel.

It is an interesting fact that life can be much prolonged and the changes in the chemistry of the blood prevented or restored to normal limits by the administration of a proper quantity of sodium chloride and water.

What then is, at present, the most reasonable explanation of the cause of death in simple obstruction of the small intestine. With the evidence as stated in mind the only logical conclusion to be drawn is that the lethal factors are produced by a loss of secretions from the stomach and upper intestine which are essential to life with a marked development of hypochloremia and dehydration. This knowledge has quite naturally led to the replacement of sodium chloride and water which has become such an important phase of the treatment of obstructive lesions of the gastro-intestinal tract.

THOMAS G. ORR.



MASTER SURGEONS OF AMERICA

LEWIS A. SAYRE

FROM the beginning down to this very day no one has influenced orthopedic surgery in this country as did Lewis Albert Sayre. And this, despite the fact that he wished to be known as a surgeon—not as an orthopedic surgeon. When the formation of the American Orthopedic Association was being debated, he opposed the plan and urged that all those interested apply for membership in the American Surgical Association, of which he was a member. He refused to join the new organization, although his sons, Lewis Hall Sayre and Reginald H. Sayre were charter members, and the former was secretary at the first meeting in 1887.

Like all really great men, Lewis A. Sayre bulked high from many points of view, which is much the same as saying that he had good friends and good enemies, and probably enjoyed his enemies as much, or more, than he enjoyed his friends. I think he may, at least for a time, have counted me among his enemies, but no one ever showed me greater personal kindness than did Doctor Sayre. It was always a proud day for me when he would drive up to my house in his open carriage, handsome pair of black horses, and coachman in livery, and shout at the top of his great voice "Ho Ridlon! Ho, Ridlon!" until someone heard him and called me to the door, and we would go for a drive. On one such occasion I asked "To what one thing more than any other do you attribute your great success as a surgeon?" Without hesitating an instant he replied "More to what I don't know than what I do know." I asked him to explain just what he meant. He said "I have never been much of a reader, and so have not known what other men have tried to do and have failed in doing. If a problem presented, I did what I thought it best to do, and have usually succeeded. But if I had known that good men had tried to do the thing and had failed, I probably would have not made the attempt, or would have failed from lack of self-confidence." This self-estimate may well be kept in mind when considering the notable incidents throughout his whole life. It explains many things, and softens the sharp lines of our criticism.

Lewis Albert Sayre was born in Battle Hill (now Madison), Morris County, New Jersey, on February 29, 1820. He died in New York City on September 21, 1900. His father, Archibald Sayre, was a farmer. His grandfather, Ephraim

Sayre, was a quartermaster in the Revolutionary Army. After the death of his father Lewis was sent as a boy of nine or ten years to Lexington Kentucky to be educated by his uncle David A. Sayre, the principal banker of that town, who had no children of his own. His uncle was a pillar of the Presbyterian church and very desirous to have Lewis study for the ministry. But when the boy graduated from the Transylvania University (Lexington, Kentucky) in 1839 he insisted upon the study of medicine, came to New York, and with little help from Uncle David, graduated from the College of Physicians and Surgeons (New York) in 1842. He was prospector to the professor of surgery for about ten years. In 1853 he was appointed surgeon to Bellevue Hospital and, in 1859 to Chantry Hospital. He was one of the most active of the founders of Bellevue Hospital Medical College, and became professor of orthopedic surgery and fractures and luxations, later designated as that of orthopedic surgery. When the College was united with the New York University in 1898 he became eminent professor of orthopedic surgery of the consolidated schools. He was one of the founders of the New York Academy of Medicine the New York Pathological Society and the American Medical Association, of which he was president in 1880.

It was in 1885 that the American Medical Association divorced from membership the New York State Medical Society for ethical infidelity (consulting with homeopaths) despite the valiant efforts of Dr. Sayre. At that time New York City had many eminent consultants while the rest of the country had relatively few and the great men of New York refused to submit to the dictation of the Chicago group. Sayre was great enough to do as he liked, lesser men wished to abrogate a law that they were unwilling to obey.

In 1860, Fernando Wood was elected mayor of New York City for the third time. He summoned Dr. Sayre to his office and offered either of two medical positions at his disposal. Dr. Sayre reminded him that he was of the opposite political party had opposed Wood's election, and would always oppose him. Wood replied that that had no bearing on the appointment. One position carried quite a large salary and only routine duties, the salary of the other was about half as much. Dr. Sayre chose the latter, that of resident physician to the City of New York, because it offered opportunity to attack sanitary evils. He continued to hold this position under the three succeeding mayors. He improved street-cleaning, the sewerage system, the small-pox situation, and tenement house evils. He demonstrated the fact, not then accepted, that cholera is a contagious, not merely an epidemic, disease, and hence amenable to proper quarantine precautions, and demanded that the Federal Government be held responsible for the protection of the entire nation.

In 1871 Dr. Sayre visited Europe and received many honors and he went again in 1877 as a delegate from the American Medical Association to the British

Medical Congress, and again received much honor. He is credited with the invention of the uvulatomer, a club-foot shoe, a scrotal clamp, the flexible probe, an improved tracheotomy tube, a periosteal elevator, a suspension apparatus, the plaster-of-Paris jacket (and Jurymast) for the treatment of Pott's disease, a traction splint for hip disease, and splints for the treatment of other tuberculous joints. As to the "Sayre suspension apparatus," still appearing as such in surgical instrument makers' catalogues, he had a lengthy controversy as to priority with Dr. Benjamin Lee, of Philadelphia, and finally admitted Lee's priority, neither of them knowing that the same apparatus had been used by Hippocrates 400 years B.C. Doubtless both he and Lee devised the same apparatus. As to the traction splint for hip disease, Dr. Henry G. Davis originated the idea of elastic traction by a splint that permitted the patient to walk. Sayre made an improved splint. But today none of the apparatuses are in use as Dr. Sayre used them. This should in no way be construed as a reflection on their author, for not one surgeon in a thousand knows how properly to "set" a Pott's fracture, having forgotten, or never heard of the method recommended by Percival Pott two hundred years ago. Any surgeon who does one good new thing that remains a good thing for as long as twice his life-time is a rare man.

Dr. Sayre was the first to excise any considerable number of tuberculous hips. He did his first excision in 1854. For the ten year period 1859-1868, he excised 29, for the ten year period 1869-1878, he excised 40, for the ten year period 1879-1888, he excised 3. After that time, none. This illustrates the greatness of the man. To be able to learn from his own work *what not to do*.

When I last called on Dr. Sayre he was reclining on a couch in his dining-room, crippled with arthritis in both knees, while the boys, Lewis and Reggy, were caring for the patients in the office across the hall. He struggled to his feet and took two or three steps to reach the box of cigars, and then back again, meanwhile urging me never to get a carriage but to walk.

In 1849, he married Miss Eliza Ann Hall, daughter of Charles Henry Hall, of New York City, who had much to do with the development of that part of the city called Harlem. All her life Mrs. Sayre sincerely believed that her husband could do no wrong. To them were born Mary Hall, Charles H. H., Lewis Hall, and Reginald H. All the sons were graduates in medicine. Charles died (by accident) before I knew the family. Lewis and Reginald were eminent practitioners of orthopedic surgery. They were my friends. They are dead. Only Miss Mary remains. In writing this short sketch of her father, I owe much to her for personal letters, for a reprint from Leslie's *History of Greater New York*, and for the picture here printed. It shows Doctor Sayre in his lusty manhood—at his very best—a great man, with a great heart that held no drop of gall. It was all sweetness.

JOHN RIDLON

Sayre, was a quartermaster in the Revolutionary Army. After the death of his father Lewis was sent as a boy of nine or ten years to Lexington, Kentucky to be educated by his uncle, David A. Sayre, the principal banker of that town, who had no children of his own. His uncle was a pillar of the Presbyterian church and very desirous to have Lewis study for the ministry. But when the boy graduated from the Transylvania University (Lexington, Kentucky) in 1839 he insisted upon the study of medicine, came to New York, and with little help from Uncle David, graduated from the College of Physicians and Surgeons (New York) in 1842. He was prosector to the professor of surgery for about ten years. In 1853 he was appointed surgeon to Bellevue Hospital, and, in 1859, to Charity Hospital. He was one of the most active of the founders of Bellevue Hospital Medical College, and became professor of orthopedic surgery and fractures and luxations, later designated as that of orthopedic surgery. When the College was united with the New York University in 1868 he became emeritus professor of orthopedic surgery of the consolidated schools. He was one of the founders of the New York Academy of Medicine, the New York Pathological Society and the American Medical Association, of which he was president in 1880.

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mentary one to Boehler's book on the treatment of fractures. Schneek realizes that many men, however dexterous in routine fracture and orthopedic work, have failed in the proper application of the non-padded cast. It is for this reason that he has outlined the description and illustrated the method from beginning to end. The book is translated from the German by a man who has spent 2 years under the personal direction of Schneek.

In the Preface, Boehler emphasizes two constant requirements in the treatment of any fracture, i.e., good reduction and uninterrupted fixation until consolidation occurs. Schneek enumerates the following factors in the cast fixation of a portion of the body, maintenance of a definite position of part of the body or extremities, elimination of muscle pull, protection of the soft parts. Schneek describes in detail the preparation of the bandages, the use of the plaster splint, and reinforcement or "reverse." He emphasizes the danger of circulatory disturbances produced by plaster of Paris and considers the surgeon responsible for the patient from the time the cast is applied until it is removed. He cautions nurses and internes to be everlastingly on guard for signs and symptoms of pressure such as changes in color, swelling, mobility, disturbed sensation, and pain. When untoward signs arise, the cast must be split or removed.

When a window is cut in a cast it should be replaced in order to prevent swelling which the author calls "window oedema." A perfectly fitting cast never causes pain. Schneek warns against allowing the cast to set while resting on a hard surface because the weight causes an indentation which will result in pressure.

All fractures should be checked by roentgenograms made immediately or soon after reduction. When roentgenograms must penetrate the cast, the dosage should be increased 10 per cent and the exposure 50 per cent.

In answer to the frequent criticism concerning the hair, he states that the hair dies in about 3 weeks and pulls out easily. When the cast is removed the skin is covered by a new growth which is not adherent to the cast.

All correction of position of the limb should be accomplished before the plaster has set to avoid the formation of wrinkles on the inside.

The following few notes will illustrate the author's attention to detail: (1) the dorsum of the toes must remain uncovered to allow free movement and observations for circulatory changes, (2) the knee joint should always be fixed in extension to prevent atrophy of the quadriceps, (3) fractures should not be immobilized in an overcorrected position, (4) the operator himself should hold the leg while the assistant applies the cast, (5) in hand casts there must be free extension and abduction of the thumb, and complete flexion at the fifth metacarpal phalangeal joint, (6) the proximal finger joint should never be held in overextension, (7) the aeroplane splint of the stock variety or of Cramer wire is preferable to plaster cast to immobilize the shoulder.

Schneek believes that Volkmann's ischæmic palsy is due to compression of the brachial artery and vein by the lower jagged edge of the proximal fragment in a supracondylar fracture near the elbow. He advises reduction with longitudinal traction on the humerus with the elbow at right angle. He discusses the proper position of the retention in cases of flat-foot.

The illustrations are well chosen and executed. The reader must be charitable in reading the translation. Regardless of whether the surgeon employs the non-padded cast or not, there is so much good information in this book that it is well worth reading. Every general, industrial, and, orthopedic surgeon should read this book.

PHILIP LEWIS.

THE presentation¹ by Schmorl and Junghans of the pathological and roentgenological anatomy of diseases, deformities, and anomalies of the spinal column will take first rank in the literature pertaining to this subject. The observations and opinions set forth are based on the findings in 10,000 spinal columns removed at necropsy, and the material is presented in such a manner as to leave no doubt concerning its scientific merits. Throughout the text the illustrations of gross sections of the spine are accompanied by roentgenograms of the same specimens. The illustrations are admirably reproduced with a uniform clarity which leaves little doubt as to the findings in each case.

In the discussion of the development of the vertebral body, Schmorl brings out some new facts particularly concerning his conception of the "so called" vertebral epiphysis. He emphasizes that unlike other epiphyses they do not add length to the vertebral growth and therefore should not be called epiphyses. These really develop in the intervertebral discs and later fuse with the vertebral bodies. Their presence as related to disease or trauma is frequently referred to in the text.

In the discussion concerning the intervertebral discs there is presented a comprehensive summary of Schmorl's ideas regarding the nucleus pulposus and annulus fibrosis. These ideas have already gained widespread recognition but have not heretofore been so clearly and completely set forth. Variation of the nucleus pulposus in normal and pathological states is fully discussed. The author states that clinically their importance may not be great but from the standpoint of traumatic condition they should be recognized.

The section pertaining to lumbosacral lesions will be of great interest to those interested in the problem of "Backache." The author distinguishes true spondylolisthesis, where forward displacement results from a solution of continuity of the pedicles or laminae, from pseudospondylolisthesis, where there may be a forward displacement due to an elongation

¹ FORTSCHRITTE AUF DEM GEBIETE DER RÖNTGENSTRAHLEN. Edited by Prof. Dr. Grashey. Sup. vol. 43. DIE GESUNDE UND KRANKE WIRBELSÄULE IM RÖNTGENBILD. PATHOLOGISCHE ANATOMISCHE UNTERSUCHUNGEN. By Gehl. Med. Rat. Prof. Dr. Georg Schmorl and Dr. med. Herbert Junghans. Leipzig, Germany: Georg Thieme, 1932.

REVIEWS OF NEW BOOKS

THE Practitioners Library of Medicine and Surgery is a series of 12 books designed by its author George Blumer as a working library for the physician and surgeon. Dr. Blumer states that the man in general practice is deluged with periodical literature and reviews. Text books grow larger and the systems of medicine being seldom revised, they quickly undergo a degenerative metamorphosis. The author feels that there is a need for a work covering the entire field of endeavor in practical medicine and surgery. Great pains have been taken to include every essential, and by thorough indexing, make the material quickly available. The majority of the contributors are young men, selected because they are abreast of the rapid changes being made in the art of healing today. This material has been arranged so that reference to a particular point is easy and where bibliographies are given they contain references to outstanding articles.

The first volume contains 371 pages of well printed material which serves as an introduction to the volumes to follow. The author states that the chief purpose of this volume is to put into the hands of the practitioner the means of orientating himself in the relationships which exist between the science and the art of medicine. The first 675 pages are used to present anatomy as far as possible from the physiological standpoint, emphasizing the bearing of various anatomical observations on clinical medicine and surgery. For example, the first chapter of 50 pages is given to "Bodily Malformations in the Light of Embryology." The balance of the section is given to brief practical statements on general anatomy with excellent anatomic illustrations taken largely from good texts on anatomy.

The second half of volume I is given to similar physiology with "emphasis upon the points bearing on the actual practice of medicine. The first chapter of this section (Chapter VIII) is given to "Hereditry in Relation to Practical Medicine and the author writes the next chapter on "General Considerations Concerning the Relation of Constitution to Disease." A fine chapter on "Energetics, Dietetics and Metabolism" together with sections on the circulation, digestion, liver, kidneys, endocrine glands, heat regulation and fever and other interesting topics make up this volume.

Volume II concerns itself with the technique of physical and laboratory examinations in clinical medicine. The editor writes the first chapter of 50 pages on history taking and the technique of diagnosis. This should be read by every medical student and used by the intern. This chapter is followed by 45 pages on physical diagnosis. A historical note accompanies each topic in the chapter on "Methods

and Instruments of Precision in Diagnosis." The section of 160 pages on the blood by Thomas E. Buckman is well arranged and it is full enough to serve as a practical manual. The illustrations are mostly new ones by Miss Piotti. Another small section on the blood appears much later in the volume. A section is given to practical technique of diagnostic pathological examinations. One hundred thirty pages are given to the technique of bacteriological and immunological examinations in the diagnosis of infectious diseases and allergy. Sturge and Root write on the endocrinopathies and diseases of metabolism. A separate section is given to tracheoscopic and bronchoscopic study. Sections on history and examinations on all of the various organs or systems of the body comprise the remainder of the volume.

M. HANSEN, B. M.D.

THE two volumes of *Yvesse's Traité de Pathologie Chirurgicale* written by J. Maisonneuve constitutes "tome II" of this extensive work. Part I deals with the lesions of the upper extremities, fractures, dislocations, traumatic lesions of the joints, deformities, neoplasms as well as lesions of the blood vessels and nerves. The work impresses one as a rather ambitious undertaking, splendidly done. Particularly well written up and illustrated are the discussions on fractures and dislocations. In this respect the work is as complete and as thorough as any recent publication dealing with that subject alone. There is perhaps an advantage from a didactic viewpoint not to limit the work to fractures and dislocations alone but to include all of the lesions. It tends to make the work more comprehensive. This volume contains 685 pages of text and 855 illustrations.

Part II is devoted to the lower extremities and follows essentially the same scheme as Part I.

The work should make a particular appeal to the surgeon interested in traumatic surgery as well as to the orthopedist. To the general surgeon and the general practitioner the work could well serve as a reference text.

GEORGE HALLERMAN.

AT the Accident Hospital in Vienna about six years ago Boehler introduced the so called non-padded plaster of Paris cast in the treatment of fractures. This cast was applied for fractures and dislocations which had been reduced under local anæsthesia and according to the method popularized by him. Dr. Schneck, the author of the book which is herewith reviewed, has been first assistant in this work for several years and this book is a complete

NEWCASTLE TREATISE ON PATHOLOGICAL CHIRURGICALS. Published under the direction of A. BARNES, G. COLLEGE, G. J. MANNING, G. MANNING, Vol. II, and of part MANNING, J. MANNING, Part I. One of the, 1911.

THE TECHNIQUE OF THE NON-PADDED PLASTER CAST. By Felix Schneck, M.D. With a preface by Lorenz Böhler, M.D. Authorized English translation by Douglas D. Telford, M.D. Volume 1. 1911.

THE PRACTITIONERS LIBRARY OF MEDICINE AND SURGERY. Vol. I. Anatomy and Physiology as related to Practical Medicine. Vol. II. The Technique of Physical and Laboratory Examinations in Clinical Medicine. New York and London: D. Appleton and Company, 1921.

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

TWENTY-SECOND ANNUAL SESSION

ST LOUIS, OCTOBER 17-21, 1932

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SURGERY GYNECOLOGY AND OBSTETRICS

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of the pedicles without any break in the bony arch.

There is an excellent discussion of metastatic lesions of the spine, and many tables illustrating the distribution of the various lesions as regards the type of tumor, age, and sex are given. The consideration of primary benign and malignant tumors is somewhat brief and a consideration of bony changes as related to primary tumors of the spinal cord and meninges might have been presented in more detail. This is the only portion of the work which seems at all inadequate.

This monograph is unquestionably a most valuable contribution to the literature, and as a reference work on conditions affecting the spine, I know of no equal. A very complete and well arranged bibliography is appended.

JOHN D. CASE

IN one of his ten books on surgical pathology Hertzler describes the surgical pathology of the vulva, vagina, cervix, uterus, tubes, and ovaries. The style of the book is most informal and the subject matter and illustrations are all drawn from the author's vast personal experience. This makes for interesting reading but gives expression to personal views which are at times unorthodox and entirely at variance with accepted teaching. The author states that carcinoma of the cervix must be diagnosed clinically and not microscopically and that "it is extremely rare for the microscope to detect a malignant lesion which cannot be diagnosed on the clinical." He further throws doubt on the existence of a precancerous lesion. The author was unfortunately in that his clientele is such that he has apparently seen but one early carcinoma of the cervix for it is obvious that the best surgical results are to be obtained in early carcinoma of the cervix before the malignancy has spread to the neighboring tissues.

The repeated misuse of the word tubercular when tuberculosis is meant might be criticized when tubercle bacillus infections result in tuberculous vulvitis or vaginitis, not in tubercular vulvitis or vaginitis.

Hertzler's *Monographs on Surgical Pathology* Series, Vol. 10, Tuberculosis, edited by Arthur C. Hertzler, M.D., Philadelphia, Moore, and London, J. W. Lippincott Company, 1924.

IN a volume of six hundred pages De Lee and Greenhill present a review of obstetrical and gynecological literature for the year 1923.

The senior editor in the obstetrical division has included reviews from all phases of obstetrics arranged under the following headings: pregnancy, labor, the puerperium, the newborn, and miscellaneous subjects. Numerous articles on the Ashheim-Zondek test for pregnancy in all its applications and modifications are fully reviewed. The practicality and unquestioned value of this test is impressed upon one more than ever after perusing the rather abundant literature accumulated on the subject during the past year. It is undoubtedly the most important contribution that has been made in this field in recent years. The treatment of obstetric posterior positions, ectoplasia, and placenta previa is given considerable space, as is cesarean section in the treatment of various complications of pregnancy and labor. The work of J. Whitridge Williams on the changes occurring at the placental site is thoroughly reviewed and illustrations of the original article is well worth the reading time of the one interested in obstetrics. In dealing with the newborn, there seems to be a dearth of literature on birth injuries as well as ways and means to prevent them. Some very interesting abstracts are to be found under the miscellaneous section of work on the child welfare, these being reviews of work on subjects by Pollock, Holmes, Adair and others.

The last three hundred pages of the volume contain a review of the gynecological literature in which the editor presents a very worth while lot of abstracts. The subject of sterility is given its rightful share of space and the importance of ectopic pregnancy, operative technique, mastectomy, and its disorders, infectious, glands of internal secretion, tumors, benign and malignant, electro-therapy and radiology are treated in the order given, each review presenting some interesting phase.

This volume is well worth having at hand as a reference to the past year's literature on these two subjects.

THE PRACTICAL MENSTRUATION SERIES
No. 10, A.M.M.D. Obstetrics
No. 10, T.A.C. Series 1924 Chicago The Year Book Publishers, Inc.

CONTENTS. Edited by Joseph
C. Greenhill, M.D. Obstetrics
No. 10, T.A.C. Series 1924 Chicago The Year Book Publishers, Inc.

AMERICAN COLLEGE OF SURGEONS

PRELIMINARY PROGRAM FOR THE ST LOUIS CLINICAL CONGRESS

A PRELIMINARY program of the clinics and demonstrations to be given in the hospitals and medical schools of St. Louis during the twenty-second annual Clinical Congress of the American College of Surgeons, October 17-21, prepared under the supervision of the Committee on Arrangements, will be found in the following pages. The surgeons of St. Louis are planning to provide a complete showing of the surgical activities of their city, with its two splendid medical schools and many fine large hospitals, for the entertainment of the Fellows of the College and their guests. During the weeks preceding the Congress the hospital schedules are to be still further revised and amplified, so that in its final form, as it will appear in the October issue of *SURGERY, GYNECOLOGY AND OBSTETRICS*, the program will present a more completely detailed schedule of the clinical work to be demonstrated.

It will be noted that clinics are scheduled for the afternoon of Monday, October 17, beginning at 2 o'clock, and for the mornings and afternoons of each of the four following days and that the program includes operative clinics and demonstrations in all branches of surgery—general surgery, gynecology, obstetrics, orthopedics, urology, proctology, ophthalmology, otolaryngology, etc.

The clinical program as published at this time is merely an outline or basis for the final program. During the Congress the clinical program will be published daily in the form of bulletins prominently displayed on large bulletin boards at headquarters at the Jefferson Hotel. These bulletins will be posted each afternoon showing in complete detail the clinics to be given on the following day. The same material will be published in printed form in the *Daily Bulletin* and distributed to the visiting surgeons early each morning.

The clinical program presented by the St. Louis surgeons will provide many special features including (1) demonstrations of modern methods in the treatment of fractures at several of the hospitals where plans have been made for a com-

prehensive showing of the methods used and the results obtained in the treatment of fractures, which forms so large a part of surgical work in large cities and industrial centers, (2) demonstrations of the treatment of cancer by surgery, radium and X-ray, (3) rehabilitation by surgery and physiotherapy of patients injured in industrial and automobile accidents, etc., (4) surgical research and experiment.

An extensive program of surgical film contributions will be presented including the newest films, both sound and silent, to be shown daily in the ballroom of the Statler Hotel.

Among the distinguished visitors from abroad who will attend the Clinical Congress and participate in its activities are Sir William I. DeCourcey Wheeler, past-president of the Royal College of Surgeons of Ireland, Sir George Lenthal Cheatle, consulting surgeon, King's College Hospital, London, Dr. José Goyanes, professor of surgery in the National Academy of Medicine of Madrid, Spain, and president of the Society of Surgeons of Madrid.

The annual meeting of the American College of Surgeons will be held in the ballroom of the Jefferson Hotel on Thursday afternoon, beginning at 1:30, for the reception of reports of officers and standing committees and for the election of officers, regents and governors.

EVENING MEETINGS

The Executive Committee of the Clinical Congress has prepared programs for a series of five evening meetings as presented in the following pages. At the presidential meeting on Monday evening in the ballroom of the Jefferson Hotel following the introduction of distinguished guests, the president-elect, Dr. J. Bentley Squier, of New York, will be inaugurated and deliver the annual address. This will be followed by the annual John B. Murphy oration in surgery delivered by Sir William I. DeCourcey Wheeler, of Dublin, Ireland. On Tuesday, Wednesday and Thursday evenings at meetings in the ballroom of the Jefferson Hotel papers on various surgical subjects of present-day interest will be presented and

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CLINICAL CONGRESS PROGRAM IN BRIEF

ALL SESSIONS AT JEFFERSON HOTEL EXCEPT AS NOTED

Monday, October 17

- 10 00. Hospital conference
- 00. Clinics in hospitals
- 1 00. Hospital conference
- 2 00. Surgical film exhibition—Statler Hotel
- 3 00. Presidential meeting.

Tuesday, October 18

- 9 00. Clinics in hospitals.
- 10 00. Hospital conference—Tuttle Memorial Auditorium
- 0 00. Surgical film exhibition—Statler Hotel
- 1 00. Clinics in hospitals
- 2 00. Hospital conference—Tuttle Memorial Auditorium
- 3 00. Surgical film exhibition—Statler Hotel
- 4 00. Hospital conference—Tuttle Memorial Auditorium
- 5 00. Scientific session, general surgery
- 6 15. Section on ophthalmology—Statler Hotel

Wednesday, October 19

- 9 00. Clinics in hospitals
- 10 00. Hospital conference—Tuttle Memorial Auditorium
- 10 00. Surgical film exhibition—Statler Hotel
- 0 00. Clinics in hospitals
- 1 00. Hospital conference—Tuttle Memorial Auditorium
- 2 00. Surgical film exhibition—Statler Hotel.

- 30. Symposium—Treatment of Fractures.
- 30. Symposium—Teaching of Surgery
- 4 00. Community Health Meeting—St. Louis University
Gymnasium
- 5 5. Scientific session, general surgery

Thursday, October 20

- 9 00. Clinics in hospitals
- 00. Hospital conference at hospitals
- 10 00. Surgical film exhibition—Statler Hotel
- 30. Annual meeting of College
- 1 00. Clinics in hospitals. Symposium on cancer
- 4 5. Scientific session, general surgery
- 5 5. Section on otolaryngology—Statler Hotel.

Friday, October 1

- 9 00. Clinics in hospitals
- 00. Surgical film exhibition—Statler Hotel
- 00. Meeting of new fellows, class of 1933
- 1 00. Clinics in hospitals
- 30. Conference on industrial medicine and traumatic
surgery
- 00. Surgical film exhibition—Statler Hotel
- 5 5. Convention.

Greetings from the President-Elect J BENTLEY SQUIER, M D, New York
 Report of the Fifteenth Annual Hospital Standardization Survey and Announcement of 1932 List of Approved Hospitals FRANKLIN H. MARTIN, M D, Chicago
 The Standardized Hospital as a Medical Education Center for the Community Profession ALLEN B. KANAVAL, M D, Chicago
 Discussion HORACE J. WHITACRE, M D, Tacoma, Wash
 Medical and Hospital Economics DANIEL CROSBY, M D, Oakland, Calif
 Discussion FREDERIC A. BESLEY, M D, Waukegan, Ill.
 How the Hospital Management and Medical Staff Can Co-operate in Reducing Mortality Rate of Appendicitis. JOHN O. BOWER, M D, Philadelphia.
 Discussion. GEORGE DAVID STEWART, M D, New York
 Oxygen Therapy in Hospitals, Equipment and Management of Service. WILLIAM THALHIMER, M D, Chicago
 Discussion GEORGE W. CREIL, M D, Cleveland

Monday—2 00-5 00 P M—Ballroom, Jefferson Hotel

Pertinent Problems Affecting Hospitals and Their Solution—From a Nation-Wide Survey E. MURIEL ANSCOMBE, R.N., St. Louis
 Discussion. W. HAMILTON CRAWFORD, Hattiesburg, Miss.
 Economic Conditions as Affecting Canadian Hospitals and How These Are Being Met. ARTHUR J. SWANSON, Toronto
 Discussion ROSS MILLAR, M D, Ottawa, Canada
 Co-operation of Hospital Boards and Hospital Executives with Medical Staffs in the Diagnosis and Treatment of Cancer BURTON J. LEE, M D, New York.
 Discussion BOWMAN C. CROWELL, M D, Chicago
 Fusing the Triple Viewpoints on Nursing—Doctors', Nurses', and Hospital Executives' MARY M. ROBERTS, R.N., New York.
 Minimum Standards for Schools of Nursing REV. ALPHONSE M. SCHWITALLA, S.J., Ph.D., St. Louis
 Discussion J. DEWEY LUTES, Chicago

Tuesday—10 00 A.M.-12 30 P.M.—Tuttle Memorial Auditorium

Symposium—Efficiency and Economics as Applied to The Clinical Laboratory J. J. MOORE, M D, Chicago
 The X-Ray Department. EDWARD H. SKINNER, M D, Kansas City, Mo
 The Physical Therapy Department. JOHN S. COULTER, M D, Chicago
 The Administration of Anæsthesia JOSEPH MC NEARNEY, M D, St. Louis
 The Administration of the Food Service EUGENIA SHRAEDER, St. Louis.
 The Handling of Surgical Dressings and Supplies SISTER PHILOMENA, St. Louis
 General Discussion opened by E. E. KING, St. Louis

Tuesday—2 00 5 00 P M.—Tuttle Memorial Auditorium

Round Table Conference Administrative, Professional, Economic, and Social Problems as Affecting Hospitals Conducted by R. C. BUERKI, M D, Madison, Wis

Tuesday—8 00 10 00 P M.—Tuttle Memorial Auditorium

Chairman's Remarks PAUL H. FESLER, Chicago
 Greetings from the Hospital Trustees of St. Louis AARON WALDHEIM, St. Louis
 Criteria to be Observed in Selecting the Governing Body of a Hospital C. W. MÜNCHER, M.D., Valhalla, N.Y.

Responsibility of the Governing Body in Selecting the Superintendent C. G. PARNALL, M D, Rochester, N Y
 Removing Hospitals from the Influence of Politics JOHN A. McNAMARA, Chicago
 Discussion E. P. HOGAN, M D, Birmingham, Ala
 How Hospital Trustees Can Keep Abreast with the Advances in Hospital Administration MATTHEW O. FOLEY, Chicago
 General Discussion opened by REV. R. D. S. PUTNEY, St. Louis

Wednesday—10 00 A M -12 30 P.M.—Tuttle Memorial Auditorium

Handling of Communicable Diseases in Connection with a General Hospital. HENRY ROWLAND, Toronto
 Discussion WALTER C. D. KIRCHNER, M.D., St. Louis
 The Individual Doctor's Responsibility for Clinical Records WALTER F. COLE, M D, Greensboro, N C
 Discussion DEWELL GANN, JR., M D, Little Rock, Ark.
 The Value and Scope of Medical Social Service Work in the Hospital. GRACE BEALS FERGUSON, St. Louis
 Discussion ROBERT E. NEFF, Iowa City, Iowa
 How the Medical Social Worker Can Assist in the Present Economic Situation RUTH LEWIS, St. Louis
 Discussion BERYL B. ANSCOMBE, R.N., Kansas City, Mo
 The Role of the Social Worker in the Diagnosis and Treatment of Cancer ELEANOR COCKERILL, St. Louis
 Discussion FRANK L. RECTOR, M D, Evanston, Ill.
 General Discussion opened by B. A. WILKES, M D, Cape Girardeau, Mo

Wednesday—2 00-5 00 P M.—Tuttle Memorial Auditorium

Round Table Conference Administrative, Professional, Economic, and Social Problems as Affecting Hospitals Conducted by ROBERT JOLLY, Houston

Thursday—9 00-12 00 A.M. and 2 00-5 00 P.M.

Discussions and demonstrations at St. Louis hospitals conducted by ROBERT JOLLY, Houston, Texas, and MALCOLM T. MACEACHERN, M D, Chicago, assisted by superintendents and heads of departments of hospitals
 Organization of the hospital, organization charts, admitting and discharging patients, demonstration of complete procedure, problems associated with clinical records, complete record systems, accounting and bookkeeping methods, simplified systems, nursing administration and nursing service, operating room management, detailed procedure in handling major operations, food service, various types of trays for general and special or therapeutic diet, management of obstetrical department, set-up for birth room, demonstration of handling supplies, organization and management of a central supply room, preparedness for emergencies in hospitals, demonstration of administrative conference

ADVANCE REGISTRATION

Attendance at the St. Louis session will be limited to a number that can be comfortably accommodated at the clinics—the limit of attendance being based upon the result of a survey of the amphitheatres, operating rooms and laboratories in the hospitals and medical schools to determine their capacity for accommodating visitors. It will be necessary, therefore, for those who wish to

discussed by a number of eminent surgeons of the United States, Canada and England.

Two meetings of special interest to ophthalmologists and otolaryngologists will be held in the ballroom of the Statler Hotel on Tuesday and Thursday evenings at which men of outstanding experience in these specialties will present papers.

The 1933 class of candidates for Fellowship in the College will be received at the annual convocation on Friday evening, on which occasion Dr. J. Bentley Squier of New York, will deliver the president's address and Robert A. Millikan, director of the Norman Bridge Laboratory of Physics of the California Institute of Technology will deliver the fellowship address.

Two special orations are included in the program: (1) the annual oration on fractures by Dr. Philip D. Wilson, of Harvard Medical School and the Massachusetts General Hospital; (2) an oration by Dr. Frederic A. Bealey, Chairman of the Board on Industrial Medicine and Traumatic Surgery dealing with the present and future activities of this department of the College work.

SYMPOSIUM: CANCER IS CURABLE

A clinical symposium that will emphasize the curability of cancer will be presented on Thursday afternoon at 2:30 in the ballroom of the Jefferson Hotel immediately following the annual meeting. Brief definite summaries of five-year cancer cures will be presented by a group of clinicians who have made a special study of cancer and the various forms of treatment. Through the Committee on the Treatment of Malignant Diseases, under the Chairmanship of Dr. Robert B. Greenough, the College is in a position to report many five-year cancer cures. If additional cases can be recorded in the literature as proof that cancer is curable it will be advantageous to the profession and will lend great encouragement to the public by impressing upon both groups the importance of early and periodic advice based on accurate diagnosis.

COMMUNITY HEALTH MEETING

The people of St. Louis and vicinity will be given an opportunity to hear an unusually interesting program of brief instructive talks dealing with personal health and hospital matters at a Community Health Meeting to be held in the gymnasium of St. Louis University at 8 o'clock on Wednesday evening. A number of distinguished physicians and surgeons and leaders in the hospital field, from various parts of the country, have been invited to deliver addresses that will be illustrated in part by lantern slides

and motion pictures. The program includes the presentation of a film on acute appendicitis created especially for exhibition to lay audiences.

HEADQUARTERS

General headquarters for the Clinical Congress will be established at the Jefferson Hotel, 12th and Locust streets, where the ballroom, Crystal and Ivory rooms and foyers adjacent thereto on the mezzanine and second floors have been reserved for the exclusive use of the Congress for scientific meetings, conferences, registration and ticket bureaus, bulletin boards, executive offices, scientific and technical exhibitions, etc. The ballroom of the Statler Hotel, at Washington and 9th streets, will be utilized daily for film exhibitions and scientific sessions on Tuesday and Thursday evenings.

TECHNICAL EXHIBITION

An interesting feature at headquarters will be the Technical Exhibition for which space has been reserved on the mezzanine floor including the Crystal and Ivory rooms and large foyers adjacent thereto. There will be represented in this exhibition the leading manufacturers of surgical instruments, X-ray apparatus, operating room lights, hospital apparatus and supplies of all kinds, ligatures, bandages, pharmaceuticals, publishers of medical books, etc.

HOSPITAL STANDARDIZATION CONFERENCE

For the fifteenth annual hospital standardization conference of the College, an interesting program of papers, round table conferences and practical demonstrations dealing with many of the problems related to the hospital standardization program of the College has been prepared. The conference opens on Monday morning at 10 o'clock in the ballroom of the Jefferson Hotel. On Tuesday morning afternoon and evening sessions will be held in the Tuttle Memorial Auditorium directly across Locust Street from the hotel. The sessions on Wednesday morning and afternoon will be held in the same Auditorium. On Thursday a series of practical demonstrations will be given in certain of the St. Louis hospitals.

The program for this annual conference has been specially planned to interest surgeons, hospital trustees, executives, nurses, etc., and the College extends an invitation to attend this conference to all persons interested in the hospital field.

Monday 10:00 A.M. 11:30 A.M.—Ballroom, Jefferson Hotel
 ALLEN B. KAYE, M.D. Chicago President, American College of Surgeons, presiding
 Address of Welcome. CURTIS H. LOWE, M.D. St. Louis.

SYMPOSIUM

TREATMENT OF FRACTURES

Wednesday, 2 30 p m —Ballroom, Jefferson Hotel

THE subject of fractures is one of perennial interest to the practicing physician and surgeon, and has an economic importance that is scarcely appreciated. The College has a committee under the chairmanship of Dr Charles L. Scudder which has been working since 1922 to improve the treatment of fractures on this continent. Correct methods applied early after occurrence of the fracture will secure optimum results. Education of the laity on the subject of fractures, as well as the education of the medical student and the practitioner in his early years, has formed one of the objectives of this committee. An increase in the number and complexity of fractures is a penalty of mechanical progress and makes incumbent upon the profession adequate preparation to meet this unfortunate situation.

The College has taken cognizance of this situation and a symposium on fractures has been prepared as an important phase of this Clinical Congress. Fractures of individual bones will be discussed from the standpoints of diagnosis and treatment by members of the Committee on Fractures and other leaders in this field. The educational value of this symposium will be measured by its subsequent effect in the diminution of the period of disability and the increase in the completeness of restoration of function of those who suffer from fractures.

TEACHING OF SURGERY AND THE SURGICAL SPECIALTIES

Wednesday, 2 30 p m —Jefferson Hotel

BELIEVING that an excellent opportunity exists to arrive at a plan for the teaching of surgery which will be possible and satisfactory, a committee has been appointed by the American College of Surgeons to study undergraduate, graduate, and postgraduate teaching of surgery and the surgical specialties. The members of the committee are Dr Fred C. Zapffe, Chairman, Dr Elliott C. Cutler, Dr Irving S. Cutter, Dr George J. Heuer, Dr Alexander R. Munroe, and Dr Allen O. Whipple.

A number of eminent teachers and clinicians of the United States and Canada have been asked to participate in a symposium on the subject to be presented on Wednesday afternoon. Meanwhile, the committee is soliciting the opinions of chiefs or heads of surgical departments in the undergraduate, graduate, and postgraduate medical schools. Based on these opinions, there will be formulated for consideration an outline of approved courses in surgery and the specialties that may be used in building courses in individual schools.

This is not an effort to standardize the teaching of surgery or the specialties. The reports will emphasize what the teachers of these subjects believe to be the best means of imparting fundamental principles, and of laying a sound foundation for future development. It is the underlying desire to arrive at the best and most effective training of the surgeon and the specialist of the future.

INDUSTRIAL MEDICINE AND TRAUMATIC SURGERY

Friday, 2 30 p m —Ballroom, Jefferson Hotel

THE care of the injured man ranks in importance with the care of those who are disabled through disease. Safety measures for the prevention of injury have been widely adopted by industry, but adequate organization for the care of those who do become ill or injured has not been provided in all industries. The College has conducted investigations and surveys in large areas of the United States to ascertain present medical conditions in industry and to inform employers of adequate methods. Some of the results of these surveys will be presented by the investigators at this symposium, which will be held under the auspices of the Board on Industrial Medicine and Traumatic Surgery, of which Dr Frederic A. Besley is Chairman. Other subjects of importance in industrial medicine and in traumatic surgery in industry and in the non-industrial world will be included.

attend the Clinical Congress in St. Louis to register in advance.

Attendance at all clinics and demonstrations will be controlled by means of special clinic tickets, which plan provides an efficient means for the distribution of the visiting surgeons among the several clinics and insures against overcrowding, as the number of tickets issued for any clinic will be limited to the capacity of the room in which that clinic will be given.

A registration fee of \$5.00 is required of each surgeon attending the annual Clinical Congress, such fees providing the funds with which to meet the expenses of the meeting. To each surgeon registering in advance a formal receipt for the registration fee is issued, which receipt is to be exchanged for a general admission card upon his registration at headquarters. This card, which is non-transferable, must be presented in order to secure clinic tickets and admission to the evening meetings.

REDUCED RAILWAY FARES

The railways of the United States and Canada have authorized reduced fares on account of the St. Louis session of the Clinical Congress so that the total fare for the round trip will be one and one-half the ordinary first-class one-way fare. To take advantage of the reduced rates it is necessary to pay the full one-way fare to St. Louis, procuring from the ticket agent when purchasing ticket, a "convention certificate," which certificate is to be presented at headquarters for the signature of the general manager of the Clinical Congress and the visé of a special agent of the railways. Upon presentation of a visé certificate to the ticket agent in St. Louis not later than October 25 a ticket for the return journey by the same route as traveled to St. Louis may be purchased at one-half the one-way fare.

In the eastern, central, and southern states and eastern provinces of Canada tickets may be purchased between October 14 and 20 in other sections of the United States and Canada at earlier dates. The return journey must be completed within thirty days from date of sale of ticket to St. Louis.

The reduction in fares does not apply to Pullman fares nor to extra fares charged for passage on certain trains. Local railroad ticket agents will supply detailed information with regard to dates of sale, rates, routes, etc. Stop-overs on both the going and return journeys may be had within certain limits.

ST. LOUIS HOTELS AND THEIR RATES

	Mo. & Me. rates	W. & C. rates
American, Market and Seventh Sts.	\$1.50	\$1.50
American Annex, Market and Ninth Sts.	.50	.50
Chase, Lindell Blvd. and Forest Park	1.00	1.00
Claridge, Locust and Eighteenth Sts.	1.00	1.00
Congress, Union Blvd. and Pershing Ave.	1.00	1.00
Coronado, Lindell Blvd. and Spring Ave.	1.00	1.00
Falmouth, Maryland and Euclid Aves.	1.50	1.50
Forest Park, W. Pine Blvd. and Euclid	1.50	1.50
Gatesworth, Union and Lindell Blvds.	1.00	1.00
Jefferson, Twelfth Blvd. and Locust St.	1.00	1.00
Kings-Way, Kingshighway and W. Pine	1.00	1.00
Robert E. Lee, Eighteenth and Pine Sts.		1.50
Lenox, Ninth and Washington Ave.	1.50	1.50
Majestic, Eleventh and Pine Sts.	1.00	1.00
Mark Twain, Eighth and Pine Sts.	1.50	1.50
Marquette, Twentieth and Washington	1.00	1.00
Maryland, Ninth and Pine Sts.	.50	.50
Maryland, Eighth and St. Charles Sts.	1.50	1.50
Malbourne, Grand Ave. and Lindell	1.50	1.50
Missouri, Locust and Eleventh Sts.	1.00	1.00
Park Plaza, Kingshighway at Maryland	4.00	4.00
Roosevelt, Delmar and Euclid Ave.	1.50	1.50
Seaton, Union Blvd. and Pershing Ave.	1.00	1.00
Scotler, Ninth and Washington Sts.	4.00	4.00
Warrick, Fifteenth and Locust Sts.	1.50	1.50

Full fare must be paid from starting point to St. Louis and it is essential that a "convention certificate" be obtained from the agent from whom the ticket is purchased. These certificates are to be signed by the general manager of the Clinical Congress and visé by a special railroad agent at Clinical Congress headquarters on or before October 21. No reduction in railroad fares can be secured except in compliance with the regulations outlined and within the dates specified. It is important to note that the return trip must be made by the same route as that used in going to St. Louis and that the certificate must be deposited at headquarters during the meeting and return ticket purchased not later than October 25.

An exception to the above arrangement is to be noted in the case of persons traveling from points in certain far western states and British Columbia, who will be able to purchase round trip summer excursion tickets which will be on sale up to and including October 15 with a final return limit of October 31. The summer excursion fare is somewhat lower than the convention fare mentioned above, but is available only in certain of the far western states and British Columbia. Tickets sold at summer excursion rates permit traveling to St. Louis by way of a direct route and returning by way of another direct route with liberal stop-over privileges.

SYMPOSIA

TREATMENT OF FRACTURES

Wednesday, 2 30 p m —Ballroom, Jefferson Hotel

THE subject of fractures is one of perennial interest to the practicing physician and surgeon, and has an economic importance that is scarcely appreciated. The College has a committee under the chairmanship of Dr Charles L Scudder which has been working since 1922 to improve the treatment of fractures on this continent. Correct methods applied early after occurrence of the fracture will secure optimum results. Education of the laity on the subject of fractures, as well as the education of the medical student and the practitioner in his early years, has formed one of the objectives of this committee. An increase in the number and complexity of fractures is a penalty of mechanical progress and makes incumbent upon the profession adequate preparation to meet this unfortunate situation.

The College has taken cognizance of this situation and a symposium on fractures has been prepared as an important phase of this Clinical Congress. Fractures of individual bones will be discussed from the standpoints of diagnosis and treatment by members of the Committee on Fractures and other leaders in this field. The educational value of this symposium will be measured by its subsequent effect in the diminution of the period of disability and the increase in the completeness of restoration of function of those who suffer from fractures.

TEACHING OF SURGERY AND THE SURGICAL SPECIALTIES

Wednesday, 2 30 p m —Jefferson Hotel

BELIEVING that an excellent opportunity exists to arrive at a plan for the teaching of surgery which will be possible and satisfactory, a committee has been appointed by the American College of Surgeons to study undergraduate, graduate, and postgraduate teaching of surgery and the surgical specialties. The members of the committee are Dr Fred C Zapffe, Chairman, Dr Elhott C Cutler, Dr Irving S Cutter, Dr George J Heuer, Dr Alexander R Munroe, and Dr Allen O Whipple.

A number of eminent teachers and clinicians of the United States and Canada have been asked to participate in a symposium on the subject to be presented on Wednesday afternoon. Meanwhile, the committee is soliciting the opinions of chiefs or heads of surgical departments in the undergraduate, graduate, and postgraduate medical schools. Based on these opinions, there will be formulated for consideration an outline of approved courses in surgery and the specialties that may be used in building courses in individual schools.

This is not an effort to standardize the teaching of surgery or the specialties. The reports will emphasize what the teachers of these subjects believe to be the best means of imparting fundamental principles, and of laying a sound foundation for future development. It is the underlying desire to arrive at the best and most effective training of the surgeon and the specialist of the future.

INDUSTRIAL MEDICINE AND TRAUMATIC SURGERY

Friday, 2 30 p m —Ballroom, Jefferson Hotel

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SURGERY GYNECOLOGY AND OBSTETRICS

PRELIMINARY PROGRAM FOR EVENING MEETINGS

BALLROOM, JEFFERSON HOTEL

Presidential Meeting—Monday Evening

Invocation.
Address of Welcome—EYARTS A. GRAHAM, M.D. St. Louis, Chairman Committee on Arrangements.
Introduction of Foreign Guests.
Address of Receiving President.
Inaugural Address: Fundamentals of Specialism. J. BENTLEY SQUIER, M.D., New York.
The John B. Murphy Oration in Surgery: Pillars of Surgery. SIR WILLIAM L. DE COURCY WHELAN, M.S. F.R.C.S.I. Dublin, Ireland.

Tuesday Wednesday and Thursday Evenings

Symposium on Surgery of the Large Bowel
Diverticulitis of the Large Bowel. VERNON C. DAVID, M.D. Chicago.
The Hopeful Prognosis of Carcinoma of the Colon. FRED W. RANKIN, M.D. Rochester, Minn.
Gynecological Symposium
The Results of Irradiation in the Treatment of Functional Uterine Bleeding. FLOYD E. KEEFE, M.D. Philadelphia.
The Detection of Clinically Latent Cancer of the Cervix. WILLIAM P. GRAVES, M.D., Boston.
Fracture Oration: Fractures about the Elbow. PHILIP D. WILSON, M.D. Boston.
Oration: Industrial Medicine and Traumatic Surgery. FREDERIC A. BESLEY, M.D. Waukegan, Ill.
Inflammation. SIR GEORGE LINTHALL CREATHE, K.C.B. C.V.O. F.R.C.S. London, England.
Brochoclectasis and Its Treatment by Lobectomy in One Stage. HAROLD BRONK, M.D. San Francisco.
A Discussion of Some Principles Involved in the Pathology and Treatment of Empyema Thoracis. JOSEPH A. DAWNA, M.D., New Orleans.
An Experimental and Clinical Study of the Use of Radium in the Brain. LOYAL DAVIS, M.D. and MAX CUTLER, M.D. Chicago.
Some Observations on Appendicitis: A Review of Four Thousand Appendectomies. J. M. T. FIDNEY, JR., M.D. Baltimore.

Convocation—Friday Evening

Invocation.
Conferring of Fellowships
Conferring of Honorary Fellowships
Presidential Address: The American College of Surgeons—Twenty Years of Ambitious Effort. J. BENTLEY SQUIER, M.D. New York.
Fellowship Address: Some New Things in Physics. ROBERT ANDREWS MILLIKAN, Ph.D. LL.D. Sc.D. Nobel Laureate. Director Norman Bridge Laboratory of Physics, and Chairman of the Executive Council, California Institute of Technology. Pasadena.

SECTION ON OPHTHALMOLOGY AND OTOLARYNGOLOGY

Ballroom, Shattuck Hotel—Tuesday and Thursday Evenings

Highways and Byways in Ophthalmology. HANS BARKAN, M.D. San Francisco.
History and Development of the Operative Treatment of Facial Palsy. ARTHUR B. DUKES, M.D. New York.
Suppuration of the Petrous Apex in Relationship to Meningitis. WELLS P. EAGLETON, M.D. Newark, N.J.

PRELIMINARY CLINICAL PROGRAM

GENERAL SURGERY, GYNECOLOGY, OBSTETRICS, ORTHOPEDICS, UROLOGY, PROCTOLOGY, SURGICAL PATHOLOGY, ETC

WASHINGTON UNIVERSITY MEDICAL SCHOOL

BARNES HOSPITAL

- EVARTS A. GRAHAM, M. B. CLOPTON, A. O. FISHER, G. H. COPPER, W. H. COLE, DR. ALLEN, W. R. RAINEY, I. Y. OLCH, R. ELMAN and P. HEINBECKER—9, daily General surgical operations
- ERNEST SACHS and ROLAND M. KLEMMIE—9, daily Neurological surgery
- JOHN R. CAULK, D. K. ROSE, J. H. SANFORD, OTTO J. WILHELM and V. R. DEAKIN—9, daily Genito-urinary surgery
- VILRAY P. BLAIR, J. B. BROWN and W. G. HAMM—9, daily Oral and plastic surgery
- J. A. KEY, ARCHER O'REILLY, J. W. STEWART, T. P. BROOKES and F. A. JOSTES—9, daily Orthopedic operations
- H. S. CROSSEN, OTTO H. SCHWARZ, F. J. TAUSSIG, Q. U. NEWELL, C. D. O'KEEFE and R. J. CROSSEN—9, daily Gynecological operations

ST. LOUIS MATERNITY HOSPITAL

- OTTO H. SCHWARZ, G. D. ROYSTON, F. P. McNALLEY, T. K. BROWN and R. PADDOCK—9, daily Obstetrical operations.
- H. S. CROSSEN, OTTO H. SCHWARZ, G. D. ROYSTON, Q. U. NEWELL, F. P. McNALLEY, O. S. KREBS, C. D. O'KEEFE, T. K. BROWN, C. R. WEGNER, R. PADDOCK, R. J. CROSSEN, M. A. ROBLEE and J. E. HOBBS—2, daily Demonstration of obstetrical and gynecological cases and specimens, clinics on cancer of the uterus, sterility and electrocoagulation

BARNES HOSPITAL, ST. LOUIS CHILDREN'S HOSPITAL, MALLINCKRODT RADIOLOGICAL INSTITUTE

Clinical Demonstrations Daily 9 and 2

- ERNEST SACHS Cases of brain tumors.
- ROLAND KLEMMIE Sympathectomy
- ERNEST SACHS and ROLAND KLEMMIE Trigeminal neuralgia.
- ERNEST SACHS and COBB PILCHER Pathology of brain tumors
- VILRAY P. BLAIR and J. B. BROWN Carcinoma about the mouth
- J. B. BROWN Carcinoma of the larynx.
- VILRAY P. BLAIR and I. Y. OLCH Pathology of parotid tumors
- J. R. CAULK (1) Transurethral prostatectomy, (2) use of the cautery punch with pathological studies of the removed tissue.
- D. K. ROSE (1) The relationship of intracystic pressure to the formation of diverticula of the bladder, (2) clinical application of the cystometer for measuring bladder pressures, (3) carcinoma of the kidney and hypernephroma
- H. L. WHITE Mechanism of urinary excretion
- I. Y. OLCH Pathology of carcinoma of the breast in relation to clinical features and mortalities.
- J. ALBERT KEY (1) Clinical and experimental observations on chronic arthritis, (2) internal derangements of the knee joint, (3) treatment of osteomyelitis with bacteriocidal ointment gauze.

- J. ALBERT KEY and FRANKLIN WALTON The effect of venous stasis on the healing of experimental fractures
- J. ALBERT KEY and ROBERT MOORE The effect of sympathectomy on the healing of bone and cartilage.
- GLOVER H. COPPER (1) The treatment of fractures of the forearm, (2) reduction of dislocation of the semilunar bone.
- ALEXIS HARTMANN The use of "combined solution" in surgery
- R. C. McCAHEE A study of the cases of pyloric stenosis in the St. Louis Children's Hospital
- J. BRONFENBRENNER (1) Discussion on the use of tetanus antitoxin, (2) clinical applications of bacteriophage.
- ROBERT ELMAN The treatment of surgical shock with particular reference to the use of acacia solutions
- WARREN R. RAINEY Minor surgical procedures about the anus and rectum.
- GLOVER H. COPPER Surgical treatment of carcinoma of the colon and rectum.
- H. A. BULGER and I. Y. OLCH Clinical and pathological manifestations of diseases of parathyroid glands.
- A. D. CARR, ROBERT F. PARKER and MARGARET SMITH The clinical and pathological manifestations of tumors of the islands of Langerhans
- N. A. WOMACK and E. A. GRAHAM The surgery of hypoglycemia.
- E. A. GRAHAM Estimating the risk in operations on the biliary tract.
- SHERWOOD MOORE and LOUIS AITKEN Technique of cholecystography
- SHERWOOD MOORE Interpretation of cholecystograms.
- DREW LUTEN The clinical syndrome of coronary thrombosis in relation to upper abdominal pain.
- JULIUS JENSEN The evaluation of operative risk through a clinical study of the circulation.
- H. L. ALEXANDER Purpura in relation to abdominal pain
- D. P. BARR Significance of pathological calcification
- D. P. BARR and LOUIS H. BEHRENS Pituitary gigantism and dwarfism
- D. P. BARR and GLOVER H. COPPER Milroy's disease, elephantiasis and the Kondoleon operation
- ROBERT EVANS Modern treatment of syphilis, especially in relation to surgical problems
- WILLIAM H. OLIMSTED Clinical management of diabetic arteriosclerosis and gangrene.
- I. Y. OLCH Pathology of the blood vessels of the extremities in gangrene.
- RALPH MUCKENFUS Diagnosis of fungus infections
- MCKIM MARRIOTT Vitamins in clinical medicine
- LAWRENCE THOMPSON Value of the Schilling hemogram in the study of acute surgical conditions
- J. F. BREDECK The tuberculin test in the diagnosis of active tuberculous infection
- DR. LLOYD Anomalies of renal veins and arteries
- GEORGE D. WILLIAMS Anomalies of the recurrent laryngeal nerve with relation to the thyroid gland.
- E. L. KEYES, JR. (1) Anomalies of the superior laryngeal nerve, (2) anomalies of the mesenteric attachment with relation to volvulus
- SHERWOOD MOORE and OSCAR ZINK The value and limitations of X-ray therapy

- J. H. SANFORD. Intravenous pyelography.
 SHERWOOD MOORE and D. K. ROSE. Interpretations of pyelograms.
 HUGH WILSON and WALTER SKIRRELL. Reduction of fractures under fluoroscopic control.
 SHERWOOD MOORE, OSCAR ZOFF and HUGH WILSON. A new interpretation of chronic arthritis.
 CHARLES O'KEEFE. Hysterosalpingography.
 J. W. LARIMORE. (1) Gastric and duodenal ulcer etiology and treatment; (2) chronic duodenal ulcers.
 H. W. WILSON. Roentgenology of extra-alimentary tumors.
 J. W. LARIMORE. Diagnosis of chronic appendicitis.
 J. W. LARIMORE, ROBERT EVANS and CHARLES DUTTON. Diagnosis of diseases of the colon.
 JOHN CAULF. Diagnosis and treatment of renal tuberculous.
 J. W. LARIMORE. Diagnosis and treatment of lesions of the esophagus.
 SHERWOOD MOORE and M. F. ARBuckle. Diagnosis and treatment of foreign bodies in the respiratory tract.
 E. A. GRAHAM. Significance of intrathoracic negative pressures.
 J. J. SINGER, ALFRED GOLDMAN, HARRY BALLOU and MILTON BENT. Diagnostic and therapeutic procedures of value in diseases of the lungs (pneumothorax, atelectasis, use of diaphragm, postural drainage).
 DR. SCHWENKER. Anomalies of origin and position of the phrenic nerve.
 E. A. GRAHAM, DUFF S. ALLEN and J. J. SINGER. Surgery in the treatment of pulmonary tuberculosis.
 PAUL D. CHENIN (Bochum Hospital, Evansville, Ind.) and CLARA MILLER (Quincy Ill.). After-cure of the tuberculous patient.
 HARRY BALLOU and H. A. MCCORDOCK. The mechanism of the development of tuberculous pneumonia following thoracoplasty.
 E. E. GIERCK. Atelectasis in pulmonary tuberculosis.
 KENNETH BURDICK, PHILIP VANNEY and DUFF ALLEN. Etiology of lung abscess.
 J. J. SINGER, DUFF ALLEN and E. A. GRAHAM. Diagnosis and treatment of lung abscess.
 J. J. SINGER, HARRY BALLOU and E. A. GRAHAM. Diagnosis and treatment of bronchiectasis.
 E. A. GRAHAM. Cautery pneumostomy for chronic pulmonary suppuration.
 H. A. MCCORDOCK. Pathogenesis of brain abscess associated with pulmonary suppuration.

- DUFF ALLEN. Hemothorax, its treatment and relation to the production of empyema.
 E. A. GRAHAM. (1) Treatment of acute empyema (2) treatment of chronic empyema.
 ELIZABETH SMITH, DUFF ALLEN and E. A. GRAHAM. Surgical treatment of heart disease.
 ALFRED GOLDMAN. Sedimentation studies on pleural fluids.
 J. V. COOKE. Mediastinal involvement of leukemia.
 J. J. SINGER, HARRY BALLOU and HERBERT CARLSON. Diagnosis and treatment of carcinoma of the lung.
 J. J. SINGER and HARRY BALLOU. Diagnosis and treatment of mediastinal tumors.
 HERBERT CARLSON. Superior vena caval obstruction.
 HARRY BALLOU and HUGH WILSON. The esophagus, stomach and heart following unilateral pleurotomy.
 HARRY BALLOU, HERBERT CARLSON and E. A. GRAHAM. The effect of pleurotomy upon cough.
 HERBERT CARLSON. Postoperative pulmonary complications.
 PETER HEIDENRECKER. The nervous regulation of respiration.
 WARREN H. COLE and NATHAN WISLOCK. (1) Experimental production of pathological changes in the thyroid gland typical of exophthalmic goiter (2) repair in the thyroid gland (3) effects of certain extracts on basal metabolism.
 WARREN H. COLE. Studies on liver function.
 ROBERT ELMAN. (1) Value of gradual decompression of the obstructed intestine; (2) the role of the pylorus in the regulation of gastric acidity.
 ROBERT ELMAN and E. A. GRAHAM. Pathogenesis of the strawberry gall bladder.
 ROBERT ELMAN and J. B. TATUM. Cholesterol fraction of the gall bladder and the formation of cholesterol gallstones.
 ROBERT ELMAN and WARREN H. COLE. Cases of death in acute portal obstruction.
 L. Y. OLSEN. (1) The use of sclero-injection in the study of surgical pathological disease; (2) studies of the liver glycogen in certain surgical diseases.
 PETER HEIDENRECKER. The sensory and motor nerve changes during spinal anesthesia.
 GLOVER H. COOPER. (1) Selective distribution of portal blood in the liver (2) effect of urinary bladder anastomosis on osteoporosis in the dog.
 J. ALBERT KEY. Infra articular anaphylaxis.
 M. B. CLIFTON. Indications for and results in splenectomy.

ST LOUIS UNIVERSITY MEDICAL SCHOOL

ST MARY'S HOSPITAL

Tuesday

- WILLIAM T. COOCHLIN—g. Brain tumor; carcinoma of the breast.
 JOHN STEWART—g. Stomach and duodenal ulcer.
 W. W. GRAY and LEROY SANTEE—g. Brain tumor and duodenal ulcer.
 PHILIP PORTMAN, FRANKLIN ALBRECHT and CARL YOUNG—g. Orthopedic clinic.

Wednesday

- WILLIAM KIRKIN—g. Gynecological operations, prolapse of uterus, carcinoma of uterus, Cesarean section.
 LEROY SANTEE—g. The X-ray in gynecology.
 WILLIAM D. COLLIER—g. Demonstration of gynecological specimens.

Thursday

- WILLIAM E. LEBESQUE—g. Cancer of the neck.
 LOUIS RABREUR—g. Gall-bladder operations.

- RALPH KIRKELLA and WILLIAM D. COLLIER—g. Demonstration of gall-bladder cases.
 C. K. BUTFORD and JOSEPH GALLER—g. Nephropathy.

Friday

- CARROLL SMITH—g. Gall operation.
 CHARLES BERGWITH—g. Carcinoma of the breast.
 RALPH A. KIRKELLA and WILLIAM D. COLLIER—g. Gall cases.
 H. H. KRANZLOFFSKY and GEORGE H. KOENIG—g. General surgical operations and demonstration of cases.

ST MARY'S INFIRMARY

Tuesday

- LOUIS RABREUR—g. Abdominal surgery.
 HARVEY S. MCKAY—g. Gall cases.

Wednesday

- WILLIAM T. COOCHLIN—g. Surgery of the head and neck.
 CARROLL SMITH—g. Surgery of the colon and rectum.
 HYMAN I. SPITZ—g. Chest surgery.

Thursday

ROBERT D ALEXANDER—9 Rectal surgery
CHARLES F SHERWIN—9 Breast surgery
PHILIP HOFFMAN—2 Orthopedic surgery

Friday

WILLIAM KERWIN—9 Gynecology
WALTER E HENNERICH—9 General surgery

ST JOHN'S HOSPITAL

Monday

Staff—2 Dry clinic, bone cases. A P BRIGGS Bone development. A E HORWITZ and C LINDEMAN Parke's disease LEO WILL Fractures JOSEPH PEDEN X-ray demonstration of bone cases
W H VOGT and associates—2 Obstetrical clinic.

Tuesday

BRANSFORD LEWIS, G CARROLL, LEO BARTELS, C D PICKRELL, G H KOENTZ, J M. SCHATZ and ROBERT F HICKEY—9 Urological operations.
O P J FALK and ANTHONY BRENNAN—9 Discussion of diagnostic and medical aspects of urological cases.
Staff—2 Dry clinic, diseases of the lungs J L MAEDER Carcinoma of lungs B McMAHON Abscess of lungs A McMAHON Heart and lungs in surgical cases
GEORGE GAFNEY Empyema

Wednesday

L M RIORDAN, PERCY H SWAHLEN, WILLIAM VOGT and M WEIS—9 Gynecological operations
Staff—9 General surgical operations WILLIAM P GLENNON Gall-bladder surgery J McHALE DEAN Stomach and intestinal operations I H BOEMER Abdominal surgery G T GAFNEY Carcinoma of the breast. A McMAHON and J J HAMMOND Discussion of diagnostic and medical aspects of these cases.
A. P MUNSCH, J McH DEAN, A McMAHON, O P J FALK and I H BOEMER—2 Borderline medical and surgical cases
C H. NELSON, F KRAMER, J McFADDEN, W P GLENNON and H N ALLEN—2 Symposium on goiter

Thursday

Staff—9 General surgical operations BRANSFORD LEWIS Urological operations WILLIAM VOGT Gynecological operations J McH DEAN Stomach and intestinal operations W P GLENNON Goiter operation W K MCINTYRE Rectal operation E H. BOWDERN Demonstration of anesthesia methods and apparatus. A P MUNSCH and H. G BRISTOW Discussion of diagnostic and medical aspects of these cases
Staff—2 Dry clinic. J P COSTELLO Diagnosis of acute abdominal conditions in children R HYLAND Traumatic surgery J McFADDEN Neurological aspects of traumatic surgery W GALLAGHER Treatment of varicose ulcers. O P J FALK and J J HAMMOND Symposium on gall bladder diseases R HYLAND The acute surgical abdomen.

Friday

Staff—9 General surgical operations P H SWAHLEN and H. J RINGO Gynecological operations WILLIAM GALLAGHER Abdominal operations. T R. KENNEDY General surgery FRED BAILEY Abdominal surgery. A J RAEMONDCK and R. F BARNES Discussion of diagnostic and medical aspects of these cases.
A A WERNER—2 Endocrine disturbance.
WILLIAM VOGT and J A HARDY—2 Ectopic gestation
A E HORWITZ—2 Orthopedic surgery

FIRMIN DESLOGE HOSPITAL

Tuesday

E A DOISI—9 Ovarian extracts
E L SHRADER—9 15 Theelin and ovarian extracts in coagulation
A A WERNER—9 30 The effect of theelin on castrates
J B MITCHELL—9 50 The action of theelin and theelol on fowl.
G O BROUN and H L LANGE—10 10 Theelin and ovarian extracts in epilepsy
W D COLLIER—10 30 The effect of theelin on the genital tract of the female white rat.

Wednesday

ALBERT KUNTZ—9 Autonomic nervous system in relation to surgery
K CHRISTIANSEN—9 30 The autonomic nervous system and special senses
G O BROUN and A P BRIGGS—9.45 Studies in bile peritonitis.
R. A KINSELLA—10 30 Bacterial endocarditis

Thursday

A B HERTZMAN and F E FRANKE—9 Demonstration and discussion of cerebral circulation
JOHN AUER—9.45 Studies on the contraction of fibrin and fibrinoid substances
A P BRIGGS—10 05 Newer aspects of nephritis
W H GRIFFITH—10 35 Food constitution in relation to food consumption (appetite)

Friday

ALBERT KUNTZ—9 Structural changes in the autonomic ganglia and ganglion cells associated with certain diseases.
PHILIP KATZMAN—9 30 Anterior pituitary hormone
M S FLEISHER and L R JONES—9 50 Serum sickness in rabbits
G O BROUN and W F HOLMES—10 10 Studies on pernicious anemia.

MOUNT ST ROSE SANITARIUM

Tuesday

Symposium on Medical and Surgical Aspects of Pulmonary Tuberculosis

C L BOISLINIERE—9 Diagnosis of pulmonary tuberculosis
E H KESSLER—9 20 Roentgen findings in pulmonary tuberculosis
ALPHONSE McMAHON—9.40 Differential diagnosis of toxic thyroid and pulmonary tuberculosis
A C HENSKE—10 30 Pneumothorax in pulmonary tuberculosis.
C W EHLERS—10 50 Oleothorax in pulmonary tuberculosis
J L MUDD—11 10 Surgical treatment of pulmonary tuberculosis

Wednesday

J L MUDD—9 Thoracoplasty and phrenicectomy

Thursday

J L MUDD—9 Thoracoplasty and phrenicectomy
J L MUDD—2 30 Exhibition of postoperative patients

Friday

J L MUDD and C W EHLERS—9 Demonstration of pneumothorax, oleothorax and phrenicectomy cases.

ST ANTHONY'S HOSPITAL

Tuesday

W. GAYLER—9. Gynecological clinic.
E. H. RUND—9. Hysterectomy.
J. E. FERRIS—10:30. Gall bladder surgery.
MURKIN SMITH—10:30. Hernia operations.

Wednesday

NEIL MOORE and E. E. SEXTON—9. Diseases of the kidneys.
WILLIS YOUNG—9:30. Plastic surgery.

MISSOURI BAPTIST HOSPITAL

Monday

C. H. SMITH—9. General surgery.
J. B. YOUNG—9. Radiology.
M. L. KLINCKFELTER—9. Demonstration of pathologic fractures.
GEORGE IVES—9. Cytologic study of cancer.
R. M. KLINCKFELTER—9. Neurosurgery.

Tuesday

E. L. DORSETT—9. Gynecological operations.
M. L. KLINCKFELTER—9. Bone and joint surgery.
J. E. OLIVER—9. Genito-urinary surgery.
H. TALBOT—9. General surgery.
W. BARTLETT and W. BARTLETT, JR.—9. Gout surgery.
R. J. CROSBY—9. Gynecology.
D. K. ROSE—9. Genito-urinary clinic.
GEORGE IVES—9. Demonstration of method of blood transfusion.
W. E. WILMER—9. Gout etiology.

Wednesday

C. H. SMITH—9. General surgery.
M. L. KLINCKFELTER—9. Bone and joint surgery.
C. E. BURFORD—9. Genito-urinary surgery.
J. B. BROWN—9. Plastic surgery.
W. BARTLETT, W. BARTLETT, JR. and J. C. LUTER—9. General surgery.
R. K. ANDERSON, O. H. CAMPBELL, C. E. GILLILAND, L. R. HENRYMAN, S. D. GRANT and J. C. LUTER—9. Internists' symposium on surgical failures.
C. E. BURFORD—9. Genito-urinary surgery.

Thursday

R. S. KEETTER—9. General surgery.
M. L. KLINCKFELTER—9. Bone and joint surgery.
W. S. WIAAT—9. General surgery.
D. K. ROSE—9. Genito-urinary surgery.
W. BARTLETT and W. BARTLETT, JR.—9. Gout surgery.
S. I. SCHWAB and W. BARTLETT—9. Psychiatric aspects of surgery.
J. B. GRANT—9. The heart in gout cases.
J. P. ATKINSON—9. Genito-urinary surgery.
J. B. BROWN—9. Industrial surgery.
J. P. MURPHY—9. The larynx in gout cases.
J. B. YOUNG—9. Physiotherapy.

Friday

M. L. KLINCKFELTER—9. Bone and joint surgery.
H. M. MOORE—9. General surgery.
O. U. NEWELL—9. Gynecological operations.
R. M. KLINCKFELTER—9. Neurosurgical operations.
W. BARTLETT, JR.—9. General surgery.
W. L. COVARD and H. F. McDONNELL—9. Dental surgery.
E. L. DORSETT—9. Gynecology.
W. BARTLETT, JR.—9. Child safety factor in gout surgery.

M. J. PULLIAM—10:30. Appendectomy

Thursday

H. S. McKAY, J. C. LUTER, M. J. PULLIAM, R. M. & BARRETT and P. NEUR—9. Stomach and gall bladder operations; consideration of medical and pathological aspects; choice of anesthetic.

Friday

H. S. McKAY, M. J. PULLIAM, R. M. & BARRETT and P. NEUR—9. General surgical clinic; demonstration of pathological specimens, lantern slides.

ST LOUIS CITY HOSPITAL

Monday

W. H. VOOT, PERCY H. SWANLEY, T. R. AYERS and W. J. HART—9. Obstetrical clinic.

Tuesday

MAX W. MYER, CHARLES F. SHELLEWY and HENRY HAMBERT—9. General surgery.
W. J. DOYLE and J. J. LEEK—9. General surgery.
FRANK REIDER and THOMAS S. WINTER—9. Industrial and traumatic surgery; dry clinic.
GRAYDON CARROLL, GEORGE H. KOTERO and CLAUDE MARTIN—9. Genito-urinary clinic.

Wednesday

EMBERT RUND, WILLIAM STUDE and S. A. WESTHEAD—9. Gynecological clinic.
H. H. HELLMAN, C. W. GARDNER, A. V. MARGARET and W. H. CLUTCHCO—9. Gynecological clinic.
JOHN W. STEWART, A. E. HOWARTH and E. L. MOORE—9. Fractures, dry clinic.

Thursday

JOHN W. STEWART and J. I. FERRIS—9. General surgery.
FRANK REIDER, J. W. THOMPSON and ROBERT S. KETTER—9. General surgery.
FRANK J. TAYLOR, WALTER C. G. KIRCHNER and W. J. DOYLE—9. Penetrating wounds of the chest and abdomen, dry clinic.
H. H. KRAMOROVSKY and BENJAMIN F. MAY—9. Genito-urinary clinic.
H. G. LOYD and P. N. DAVIS—9. Genito-urinary clinic.

Friday

FRANK J. TAYLOR and W. J. GALLAGHER—9. General surgery.
THOMAS S. WINTER and N. M. FERRIS—9. General surgery.
CHARLES F. SHELLEWY and LEROY SMITH—9. Surgical and radiological treatment of cancer; dry clinic.

ROBERT KOCH HOSPITAL

Wednesday

Staff—9. Dry clinic. H. J. SPENCER. Diagnosis and treatment of pneumoconiosis complicated by pulmonary tuberculosis. DUFE S. ALLEN and GEORGE KETTERHAM. Surgical treatment of bilateral pulmonary tubercular partial apical thoroplasty versus pleurotomy in pulmonary tuberculosis. A. E. HOWARTH. Subtrochanteric osteotomy for contracture hip deformity. GEORGE S. WILSON. Schilling blood count in respect to the surgical treatment of pulmonary tuberculosis. RALPH DODDICK. Artificial pneumothorax in the treatment of pulmonary tuberculosis in the negro.

JEWISH HOSPITAL

Tuesday

- ELLIS FISCHER, ERNST JONAS and J PROBST—9 General surgery
 SAMUEL NEWMAN—9 Rectal surgery
 H. EHRENFEST, F J TAUSSIG, S A WEINTRAUB, GROVER LIESE, S F ABRAMS and Dr PATTON—2 Obstetrical clinic.
 Drs GREY and SOMOGYI—2 Demonstration and discussion of experimental work of surgical significance

Wednesday

- R M KLEMMIE—9 Neurosurgical clinic
 H. EHRENFEST, F J TAUSSIG, S A WEINTRAUB, GROVER LIESE, S F ABRAMS and Dr PATTON—9 Gynecological operations
 Drs SINGER, SIMON and FRANK—2 Medical and surgical thoracic clinic with demonstration of unusual X-ray films

Thursday

- MAX W MYER, HARRY SANDPERL, E V M MASTIN and E K. DIXON—9 General surgery
 B MAY, D K. ROSE and McCURE YOUNG—9 Genito-urinary surgery
 Medical Staff—2 Pre-operative medical care of patients.
 PAUL LOWENSTEIN and J PROBST—3 Technique of injection of varicose veins

Friday

- ELLIS FISCHER, WILLARD BARTLETT and PAUL LOWENSTEIN—9 General surgery
 F H ALBRECHT, FRED JOSTES and J A KEY—9 Orthopedic surgery
 S GREY—2 Pathological demonstration
 B MAY, D K ROSE and McCURE YOUNG—2 Urological dry clinic.
 P C SCHNOEBELE—3 X-ray demonstration of gastrointestinal lesions.

SHRINERS' HOSPITAL

Tuesday

- C. H. CREGO—9 Operative lengthening of tibia and fibula.
 C. H. CREGO—2 Leg lengthening cases, end-results

Wednesday

- J B BROWN—9 End-results after split thickness skin grafts
 Staff—2 Orthopedic end-results

Thursday

- C H CREGO—9 Orthopedic operations
 J A KEY—2 Orthopedic clinic

ST LOUIS COUNTY HOSPITAL

Tuesday

- F A JOSTES—9 Orthopedic clinic.

Wednesday

- E L DORSETT—9 Gynecology

Thursday

- W E LEIGHTON—9 General surgery

Friday

- F L DAVIS—9 Genito-urinary surgery

BARNARD FREE SKIN AND CANCER HOSPITAL

Tuesday

- FRED J TAUSSIG, S S LEVIN, E S AUER and FRED EMMERT—9 Surgery and radium therapy in cancer of the uterus and vulva
 FRED J TAUSSIG, GEORGE GELLHORN, S S LEVIN, E S AUER, FRED EMMERT, KATE SPAIN and MARION WACHOWIAK—2 Malignancy index in gynecological cancer, technique of vulvar operations, exhibition of specimens

Wednesday

- ELLIS FISCHER, CHARLES F SHERWIN and GEORGE GAFNEY—9 Radical surgery and interstitial radium therapy
 D P BARR, C M STROUD and E C ERNST—2 Internal medicine and radiography in relation to cancer

Thursday

- GEORGE GELLHORN, S S LEVIN, E S AUER, FRED EMMERT, KATE SPAIN and MARION WACHOWIAK—9 Surgery and radium therapy in cancer of the uterus
 M G SEELIG, L H JORSTAD and E C ERNST—2 Demonstration of the production of tar cancer, pathological specimens, X-rays and photomicrographs of unusual problems in malignancy, specimens of crown gall in plants produced by bacillus tumefaciens, studies of mitochondria in cancer, reticulum in cancer growth

Friday

- W E LEIGHTON, GRAYSON CARROLL, THOMAS M MARTIN and J C LANDREE—9 Surgical cancer therapy
 M F ENGMAN, RICHARD WEISS, A H CONRAD, C V LANE and M F ENGMAN, JR—2 Amebic and phagedenic ulcers and ulcers of unknown cause, presentation of cases, lantern slides

ST LUKE'S HOSPITAL

Tuesday

- J H SANFORD, JOHN R CAULE, OTTO WILHELM, JOHN PATTON and C E BURFORD—9 Genito-urinary surgery
 D STUTZMAN—10 Genito-urinary clinic
 J H SANFORD—11 Diagnosis and treatment of kidney lesions
 O C ZINK—11 X-ray interpretation
 R. M. KLEMMIE—11 30 Brain abscess

Wednesday

- C D O'KEEFE, OTTO KREBS, ROBERT CROSSEN and EDGAR SCHMITZ—9 Gynecological operations
 J VAUGHN and GREY JONES—10 Obstetrical and gynecological clinic.
 C D O'KEEFE—11 Ovarian cysts
 OTTO KREBS—11 30 Sterility

Thursday

- R M KLEMMIE—9 Neurological surgery
 A O'REILLY and J E STEWART—9 Orthopedic surgery
 J E STEWART—10 30 Orthopedic clinic
 J E STEWART—11 30 Fractures of upper third of femur
 O C ZINK—11 30 X-ray demonstration

Friday

- O R SEVIN—9 General surgery
 L KEYES, C E HYNDMAN, E V MASTIN and E K. DIXON—10 General surgical clinic.

SURGERY GYNECOLOGY AND OBSTETRICS

LUTHERAN HOSPITAL

DEPAUL HOSPITAL

- Tuesday**
 EDWARD J. O'MALLEY and HENRY A. HAMMETT—g. Surgical clinic, outpatient department.
 FRANK TAYLOR, ROBERT E. SCHULTZ and R. DICKET KAPOR—g. General surgical operations.
 H. H. KRAMOWITZ—g. Genito-urinary clinic, moving pictures.
 C. J. ALTHAUS—g. Genito-urinary operations.
 ROGERS DEAN—g. Renal tuberculosis.
 J. F. BRECKEN—g. Schiffing differential count in surgical diagnosis.
 L. D. CANT—g. Postoperative neuritis

- Monday**
 T. P. BROOKES—g. Dislocations of the cervical spine, complications, demonstration of cases, lantern slides and moving pictures.
Tuesday
 H. L. NORTON—g. General surgical operations.
 J. L. HUTTON, V. KLOPFER and F. DENTO—g. General surgical operations.

- Wednesday**
 J. W. THOMPSON, ARTHUR GUNDELACH, E. J. O'MALLEY and C. E. HYNDMAN—g. General surgical operations.
 V. P. BLAIR, J. B. BROWN and W. S. HAMM—g. Plastic surgery.
 H. W. SOMER—g. Diathermy in benign and malignant lesions of rectum.
 OLIVER ABEL, JR.—g. Estimating the cardiac factor in surgical risk.
 CHARLES EYENMAN—g. Allergy in surgical diagnosis.
 D. B. FLAYAN—g. Chemical electrocardiography.
 T. WINTER WHITE—g. Pneumococcus peritonitis in child.
 T. WINTER WHITE—g. Differential diagnosis for appendicitis

- Wednesday**
 R. E. SCHULTZ and H. P. TAYLOR—g. General surgical operations.
 H. A. HAMMETT, T. H. HAMMETT, and A. G. KLEPP—g. General surgical operations with apical anastomosis.
 H. A. HAMMETT, T. H. HAMMETT, and A. G. KLEPP—g. Embolotomy demonstration of cases.
 E. W. SPENCER—g. Roentgenological diagnosis of splenic and traumatic pneumoperitoneum.

- Thursday**
 J. L. HUTTON, V. KLOPFER and F. DENTO—g. General surgical operations.
 H. L. NORTON—g. General surgical operations.
 H. G. LOVO and JAMES O'DOWD—g. Urological operations

- Friday**
 H. A. HAMMETT, T. H. HAMMETT, and A. G. KLEPP—g. General surgical operations, apical anastomosis.
 R. E. SCHULTZ and H. P. TAYLOR—g. General surgical operations.
 G. O. GAUTH and E. A. VOGEL—g. Obstetrical operations.

MISSOURI PACIFIC HOSPITAL

- Tuesday**
 O. B. ZIEGLER and associates—g. General surgical operations.
 W. P. ELMER and associates—g. Medical diagnostic clinic.
Wednesday
 I. H. BOESCH and associates—g. Abdominal surgery.
 W. K. MUELLER and associates—g. Roentgenological clinic.
 H. J. SCHENCK and associates—g. Genito-urinary surgery.

- Thursday**
 A. O. FISHER and associates—g. General surgical operations.
 W. P. ELMER and associates—g. Medical diagnostic clinic.

- Friday**
 O. B. ZIEGLER and associates—g. General surgical operations.
 W. K. MUELLER and associates—g. Roentgenological clinic.
 J. H. SANFORD and associates—g. Genito-urinary surgery.

BETHESDA HOSPITAL

- Tuesday**
 ROLAND HILL and B. W. KLIPPEL—g. General operations.
Thursday
 ROLAND HILL and B. W. KLIPPEL—g. General operations.

FRISCO EMPLOYEES' HOSPITAL

- Wednesday**
 R. A. WOOLLEY—g. Back injuries and back conditions.
Thursday
 R. A. WOOLLEY—g. General surgical operations.

U. S. VETERANS' HOSPITAL

- Tuesday**
 S. L. FIELDS—g. General surgical clinic.
 J. E. WINTER—g. Orthopedic clinic.

DEACONESS HOSPITAL

Monday

HERMAN NIETERT, FRANCIS REDER, FRED BAILEY, JOHN C MORFIT, ROBERT E SCHLUETER and A R SHREFFLER—2 Medico-surgical dry clinics

Tuesday

FRED W BAILEY, WILLIAM H NORTON, A V MARQUARDT, LEO A WILL and J EDGAR STEWART—9 General surgery and orthopedic operations
A R SHREFFLER, EDWIN SCHISLER, M L KLINEFELTER, GUY STIMPSON, N C GAYLOR and DREW LUTEN—2 Medico-surgical clinical demonstrations

Thursday

E LEE DORSETT, N C GAYLOR, JOHN W STEWART, FRED W BAILEY, FRANCIS REDER and HERMAN NIETERT—9 General surgical and gynecological operations

SURGERY OF THE EYE, EAR, NOSE, AND THROAT

WASHINGTON UNIVERSITY MEDICAL SCHOOL

BARNES HOSPITAL

Monday

FREDERICK O SCHWARTZ—2 Ophthalmological operations, strabismus

Tuesday

L W DEAN and staff—9 Ear, nose and throat conference
M F ARBUCKLE and A W PROETZ—11 Otolaryngological operations
MEYER WIENER—2 Ophthalmological operations

Wednesday

L W DEAN and staff—9 Ear, nose and throat conference
HARVEY J HOWARD—2 Ophthalmological operations, demonstrating albinism, scleroconjunctiva suture, intracapsular cataract extraction

Thursday

L W DEAN and staff—9 Ear, nose and throat conference

Friday

A J COVE, B J McMAHON and WILLIAM L HANSON—9 Otolaryngological operations
J B COSTEN, L J BIRNBER and F K HANSEL—11 Otolaryngological operations
H ROMMEL HILDRETH—2 Plastic surgery of the eye

McMILLAN HOSPITAL

Daily, 9 00 and 10 30

Staff—Clinical lectures and demonstrations
LAWRENCE T POST Slit lamp demonstration
WILLIAM E SHAHAN Physiological apparatus (including thermophore)
WILLIAM F HARDY Ocular muscles
H ROMMEL HILDRETH Ultraviolet light therapy
B Y ALVIT Cylinder skiascopy
M HAYWARD POST Advanced refraction technique
FREDERICK E WOODRUFF Ophthalmoscopy
MAX W JACOBS Ocular changes during pregnancy
J E JENNINGS Color vision tests
ROY E MASON Industrial ophthalmology

L H HEMPLEMAN, LEO BROOKS, CLAUDE PICKRELL, CHARLES A STONE, JOHN C MORFIT, M F ARBUCKLE and FRED C SIMON—2 Clinical demonstrations

U S MARINE HOSPITAL

Monday

J L SMITH—2 Clinical demonstration of abscess of lung

Tuesday

W M JONES—10 General surgical operations
W L COREY—2 Clinical demonstration of abdominal tumor with obstruction of transverse colon

Thursday

W M JONES—10 General surgical operations
J T DELOUGHERTY—2 Clinical demonstration of pyloric obstruction of stomach

Friday

W M JONES—10 General surgical operations

Monday

HOWARD C KNAPP—2 Ocular tuberculosis clinic
MEYER WIENER—2 Diagnostic eye clinic
WILLIAM M JAMES—3 Ocular syphilis clinic
F K HANSEL—2 Allergic clinic
C C BUNCH—2 Hearing tests
H N GLICK, HELEN GAGE, ALLEN POTTER, and L C BOEMER—3 Otolaryngological diagnostic clinic
A W PROETZ—4 Demonstration of cases

Tuesday

M HAYWARD POST—2 Diagnostic eye clinic
F K HANSEL—2 Allergic clinic
C C BUNCH—2 Hearing tests
H N GLICK, HELEN GAGE, ALLEN POTTER, L C BOEMER and GEORGE SAUNDERS—3 Otolaryngological diagnostic clinic
I Y OLCH and CLIFFORD MENZIES—4 Demonstration of cases, pathology of ear, nose and throat.

Wednesday

HOWARD C KNAPP—2 Ocular tuberculosis clinic
WILLIAM E SHAHAN—2 Diagnostic eye clinic
WILLIAM M JAMES—3 Ocular syphilis clinic
F K HANSEL—2 Allergic clinic
C C BUNCH—2 Hearing tests
H N GLICK, HELEN GAGE, ALLEN POTTER, L C BOEMER and GEORGE SAUNDERS—3 Otolaryngological diagnostic clinic
L K GUGGENHEIM and DOROTHY WOLFF—4 Demonstration of cases, embryology and anatomy of ear, nose and throat

Thursday

WILLIAM F HARDY—2 Diagnostic eye clinic
HARVEY J HOWARD—3 Clinical conference in ophthalmology
F K HANSEL—2 Allergic clinic
C C BUNCH—2 Hearing tests
H N GLICK, HELEN GAGE, ALLEN POTTER, and L C BOEMER—3 Otolaryngological diagnostic clinic
W F WENNER and P R NEMOURS—4 Demonstration of cases, physiology of ear, nose and throat

- Friday*
 HOWARD C. KILPATRICK—3. Ocular tuberculosis clinic
 LAWRENCE T. POST—3. Diagnostic eye clinic
 WILLIAM M. JAMES—3. Ocular syphilis clinic
 F. C. HANCOCK—3. Allergic clinic
 C. C. BOWEN—3. Hearing tests
 H. N. OLICK, HELEN GAGE, ALLEN POTTER and L. C. BOWEN—3. Otolaryngological diagnostic clinic.

CHILDREN'S HOSPITAL

Tuesday

- H. W. LYMAN, I. D. KELLEY, JR. and L. E. FREEMAN—
 Otolaryngological operations

Friday

- O. F. HUGHES and A. M. ALDER—3. Otolaryngological operations.

OSCAR JOHNSON INSTITUTE

- Staff—Daily 9:00 and 1:30. Laboratory demonstrations.
 HARVEY D. LAMAR. Pathology of the eye.
 WILLIAM M. JAMES. Conjunctival cytology
 H. ROSENTHAL. Anatomy of eye and orbit
 GEORGE H. BURNER and B. HOWARD BARTLEY. Physiology of the eye.
 FRANK W. COLE. Physiological optics
 CHARLOTTE WEINBERG. Chemistry relating to ophthalmology
 ROSEMARY A. HETTLER. Nutrition relating to ophthalmology
 LOUIS A. JULIANELLI and MARION C. MORRIS. Bacteriology of the eye
 R. WARDWELL HARRISON. Tissue culture of the eye.

ST. LOUIS UNIVERSITY MEDICAL SCHOOL

HIRSHIN DESLOGE HOSPITAL

Tuesday

- JOHN GREEN—3. Local use of epinephrin and epinephrin substitutes as adjuvants to antibiotics in the treatment of glaucoma, strabismus, with demonstrations.
 J. F. HARRINGTON—3:30. Immediate reduction of intra-ocular hypertension by constitutional treatment, with clinical demonstrations
 M. L. GREEN—3. Whipped keratotomy with basal iridectomy for acute or chronic glaucoma, Leucke operation, with demonstrations and review of results
 ALBERT KUHN—3:30. Fundamental principles in neurological and mechanical control of intra-ocular pressure.

Wednesday

- W. H. LUTHER—3. The new Baughman Chaudryman super past magnet
 M. L. GREEN—3:30. The giant magnet in ophthalmic practice, experimental tests showing its wide range of power suggestions for its use in laryngology and bronchoscopy
 W. E. LUTHER—3. Usefulness of giant magnet in general surgery with experimental demonstrations.
 HOOVER KERN—3:30. Ocular by products in industrial surgery

Thursday

- EDWARD T. SCHMIDT—3. Otolaryngological operations.
 LAURA LANE (by invitation)—3. Ocular tumors, with demonstrations from Winterstein collection.

- Staff—Daily 1:00. Laboratory demonstrations, otology, gynecology

- GEORGE E. HUGHES, LOUIS J. BOWEN, JAMES B. COFFEY, HARRY N. GAGE, I. D. KELLEY, JR. and DONALD WOOD. Anatomy
 W. F. WARDWELL and P. R. KENDRICK. Physiology
 CATHERINE SCHNEIDER. Chemistry
 EVELYN DUDLEY. Bacteriology
 L. W. DRAKE. Cytology
 A. J. COLE. Temperature changes
 LOUIS K. GOODWIN. Embryology
 ARTHUR W. FROST. Stomach study
 B. J. McMANUS and CLIFFORD STEVENS. Pathological studies

CENTRAL INSTITUTE FOR THE DEAF

Wednesday and Thursday

- MAY A. GOLDSTEIN, JULIA M. CONVERY and Staff—10. Recent developments in the training of the deaf child, preschool deaf child, the first instruction in speech and lip-reading; conservation of residual hearing; a play by deaf children; the end products of training.
 MELROD A. MCGINNIS and staff—1. The operation of a clinic for the correction of defects in speech with demonstration of selected types of cases.
 HELEN M. GERRANT and VIVIAN GROSS—2. Partial accomplishments in lip reading.
 R. LOWERY DE NO, HELEN F. SCHMIDT and MAY A. GOLDSTEIN—10. Some phases of special laboratory research in pure anatomy, phonetics, acoustics and psychology as applied at Central Institute for the Deaf.

- J. M. KELLEY and C. J. QUINN—30. Ocular trauma, with demonstrations from Winterstein collection.
 JOSEPH MULLER (Hamburg, Germany)—3. Sympathetic ophthalmia, with demonstrations from Winterstein collection
 CARL T. EKER—3:30. Moving picture demonstration. Cataract operation, Leucke technique for glaucoma operation
 W. H. LUTHER—3:45. Successful destruction of intra-ocular pigmented new growth by localized controlled heat (Schlosser thermopneum). Demonstration of various cases after four years.

Friday

- L. C. DUBOIS—3. Serological control of retinitis pigmentosa, review of clinical evidence.
 R. L. JOHNS and FRANCIS J. ROSEN—30. Preparation and distribution of ocular extract for retinitis pigmentosa
 W. H. LUTHER—3. Surgical significance of mechanical factors in ocular accommodation, mechanical factors in progressive myopia and their control; presentation of cases
 CARL T. EKER—3:30. Moving picture demonstration. Cataract operation, Leucke technique for glaucoma operation.

ST. MARY'S HOSPITAL

Monday

- W. E. BAUER, S. B. WESTLAKE, P. H. MILLIGAN and C. O. BROWN—3. Otolaryngological operations.

WILLIAM H. LUEDDE, JOHN GREEN and associates—2
Ophthalmological clinic.

C. E. RICE—2 Surgical treatment of trachoma.

Tuesday

C. E. RICE—2 Surgical treatment of trachoma.

Wednesday

JOHN GREEN and associates—2 Ophthalmological clinic.

Thursday

W. E. SAUER, S. B. WESTLAKE, R. H. MILLIGAN and
C. O. BROWN—2 Otolaryngological operations

ST ANTHONY'S HOSPITAL

Monday

F. G. A. BARDENHEIER—2 Otolaryngological operations

C. J. GISSY—2 Ophthalmological clinic, operations and
demonstration of cases

Wednesday

J. M. KELLER—2 Ophthalmological clinic, operations and
demonstration of cases

Friday

F. G. A. BARDENHEIER—2 Otolaryngological operations

ST MARY'S INFIRMARY

Tuesday

WILLIAM E. SAUER—2 Aural surgery

Wednesday

J. F. HARDESTY and associates—2 Ophthalmological
clinic.

DEPAUL HOSPITAL

Tuesday

V. V. WOOD—2 Otolaryngological operations

L. J. BIRSNER—2 Anatomy of neck in relation to deep
infections originating in throat and their surgical
treatment.

W. P. DONOVAN—2 Otolaryngological operations

Wednesday

T. P. LAWTON—2 Otolaryngological operations

GEORGE HOURN—2 Otolaryngological operations

Thursday

W. E. SAUER—2 Otolaryngological operations

V. V. WOOD—2 Otolaryngological operations

W. P. DONOVAN—2 Otolaryngological operations

G. H. POOS—2 Ophthalmological operations

LUTHERAN HOSPITAL

Tuesday

F. C. SIMON—2 Otolaryngological operations.

H. N. GLICK—3 Surgical consideration of structure of
petrous pyramid, demonstration of specimen, lantern
slides

Wednesday

A. HOOS—2 Eye operations.

Thursday

F. C. SIMON—2 Otolaryngological operations

FREDERICK O. SCHWARTZ—2 Eye operations

ST JOHN'S HOSPITAL

Tuesday

E. P. NORTH, V. L. JONES, N. R. DONNELL and JOHN
McGRATH—2 Demonstration of ophthalmological
cases

C. F. PFINGSTEN—2 Otolaryngological operations

Thursday

V. V. WOOD—2 Demonstration of otolaryngological cases

Friday

V. V. WOOD and ELMER SCHLUER—9 Otolaryngological
operations

ALEXIAN BROTHERS HOSPITAL

Monday

J. M. KELLER—3 Ophthalmological clinic.

Tuesday

D. P. FERRIS—2 Otolaryngological clinic.

Wednesday

C. J. GISSY—3 Ophthalmological clinic.

Thursday

D. P. FERRIS—2 Otolaryngological clinic.

MOUNT ST ROSE SANITARIUM

Wednesday

WILLIAM SMIT—2 30 Otolaryngological clinic.

Friday

WILLIAM SMIT—2 30 Otolaryngological clinic.

MISSOURI PACIFIC HOSPITAL

Tuesday

W. G. PATTON and associates—2 Otolaryngological
operations.

Wednesday

EMMETT P. NORTH and VINCENT L. JONES—2 Ophthal-
mology, diagnostic and operative clinic.

S. B. WESTLAKE and associates—2 Otolaryngological
operations

Thursday

W. G. PATTON and associates—2 Otolaryngological
operations

Friday

W. G. PATTON and associates—2 Otolaryngological
operations

ST LOUIS CITY HOSPITAL

Tuesday

CARL T. EBER—2 Ophthalmological operations

E. LEE MYERS—2 Otolaryngological operations

Friday

E. LEE MYERS—2 Otolaryngological operations

FRISCO EMPLOYEES' HOSPITAL

Wednesday

RICHARD J. PAYNE—2 Pulmonary lavage.

J. ELLIS JENNINGS—3 Practical tests for color blindness,
several color blind persons will be examined

JEWISH HOSPITAL

Monday

- ROBERT T. SEMERLEY—2. Radical mastoidectomy
 I. D. KELLEY JR.—2. Direct vision adenectomy
 A. M. ALDER—2. Classic closure of mastoid fistula.

Tuesday

- MAX W. JACOBS and R. Y. ALPER—2. Ophthalmological clinic, operations and demonstration of cases.

Wednesday

- L. LEX MYERS and staff—2. Demonstration of bronchoscopy cases, laryngectomy
 C. E. EDGER—2. Direct laryngoscopy examination (Hassinger)
 I. D. KELLEY JR.—2. Lynch suspension.
 M. D. PELL, O. R. DOWNS and MAXWELL FINKELBERG—2. Diagnostic clinic with demonstration of cases.

Thursday

- METTER WIEBER—2. Ophthalmological operations.

Friday

- LOUIS K. GOODENOUGH—2. Demonstration of cases.
 A. M. ALDER—2. Barka and guillotine tonsillectomy and demonstration of ligature of bleeder dacryorhinocystotomy
 S. B. WESTLAKE—2. Radical mastoidectomy

MISSOURI BAPTIST HOSPITAL

Monday

- R. J. PAYNE—2. Otolaryngological operations.
 H. N. GLUCK—2. Otolaryngological operations.

Wednesday

- R. J. PAYNE—2. Otolaryngological operations.
 H. N. GLUCK—2. Otolaryngological operations.
 J. F. HANSEN—2. Ophthalmological operations

ST. LOUIS COUNTY HOSPITAL

Monday

- O. W. KOCK, J. B. COSTER and A. M. ALDER—2. Otolaryngological operations.

Wednesday

- C. P. DYER, WILLIAM F. HARDY and JERRY McGRATH—2. Ophthalmological operations and demonstration of cases.

Friday

- JOHN GREEN and CARL BEHRMANN—2. Ophthalmological operations.

ST. LUKE'S HOSPITAL

Monday

- W. E. SKRABIN—2. Ophthalmological operations.

Tuesday

- B. J. McMANIS—2. Otolaryngological operations.

Thursday

- B. J. McMANIS—2. Otolaryngological diagnostic clinic.

DEACONESS HOSPITAL

Monday

- V. V. WOOD—2. Otolaryngological clinic.
 F. C. EMMET—2. Otolaryngological operations.

Wednesday

- V. V. WOOD—2. Otolaryngological clinic.
 F. C. EMMET—2. Otolaryngological operations.

U. S. VETERANS' HOSPITAL

Tuesday

- P. H. FROST—2. Ophthalmological and otolaryngological clinic.

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MUCOID CARCINOMA OF THE GASTRO-INTESTINAL TRACT

SO CALLED COLLOID CANCER

THEODORE S. RAIFORD, M.D., BALTIMORE, MARYLAND

From the Departments of Surgery and Surgical Pathology of the Johns Hopkins Hospital and University

THE term "colloid carcinoma" has been used loosely for many years to designate a tumor characterized by acellular gelatinous deposits. Tumors of this type may occur wherever mucus-secreting cells are found. They are common in the breast, ovary, and kidney, have been described in the gall bladder, bronchi, cervix, and urinary bladder, but are most common in the gastro-intestinal tract. The term, as suggested by Virchow, is applicable in a descriptive sense but does not indicate the real nature of the tumor. As a result of controversy in regard to nomenclature, the growth has been described under a variety of terms, such as mucoid carcinoma, gelatinous carcinoma, myxoma, myxocarcinoma, etc. Although the term "colloid" is in common use, it is somewhat misleading. Colloid, as now used, applies to the gelatinous substance found in the thyroid gland, a substance which differs widely both in its staining properties and chemical composition from the material found in gelatinous tumors. The amorphous material has properties similar to mucin and since its origin can be traced to mucus-secreting cells, it is preferable to discard the name "colloid" and adopt the term "mucoid" as a more accurate term.

A survey of 123 cases of mucoid carcinoma of the gastro-intestinal tract forms the basis

of this study and allows certain conclusions to be drawn regarding the etiology and nature of the tumor.

DISTRIBUTION OF CASES

Table I gives the distribution of these tumors and their relative frequency in respect to other proved gastro-intestinal carcinomata.

Stomach Although the stomach is most frequently the site of neoplastic growth of all types, relatively few, 11.8 per cent, show the presence of mucoid material. This incidence is considerably higher than that of Klein and Parham, whose figures were 2.5 and 6.5 per cent, respectively.

Small intestine Two, or 1.43 per cent, of the 14 carcinomata located in the small intestine showed the presence of mucoid deposits. The series is small but indicates the infrequency of this type of cancer in the small intestine.

Appendix Of 3 carcinomata arising in the appendix, 1 was of the mucoid variety. This does not include the carcinoids and is perhaps misleading.

Colon Mucoid carcinomata are most prevalent in the colon, comprising 30 per cent of all cancers found in this region. This figure is likewise higher than that of Parham, who found mucoid change in only 9 per cent of 375 cases. Investigating the distribution through

out the colon more closely it is found that the frequency varies with the location. These tumors are for example, relatively more common in the transverse colon and hepatic flexure less frequent in the cecum and ascending colon and relatively rare in the splenic flexure descending colon and sigmoid.

Rectum. Forty-one or 24 per cent, of 166 carcinomata of the rectum showed the presence of mucus in atypical deposits.

It should be apparent from these figures that mucoid carcinoma is most frequently encountered in the large bowel. This is to be expected in view of the increased numbers of mucus-secreting cells, if one accepts the assumed relationship between these cells and mucoid carcinoma.

A word is necessary to explain the discrepancy between the incidence reported here and that reported by other authors. All cases have been included in this series which show microscopically increased deposits of mucus regardless of amount, and the number has not been limited to those cases showing gross accumulations.

AGE, RACE, AND SEX INCIDENCE

Patients with mucoid carcinoma are most frequently in the first part of the sixth decade of life. There is a slight variation in age incidence in different parts of the gastro-intestinal tract, and in general it may be said that the lower the location of the tumor the younger the age of the patient. This is to be expected when one considers that tumors of the rectum and colon produce more acute symptoms and are thereby recognized earlier.

The disease occurs far more commonly in whites than blacks, 90.4 per cent being in the former race.

Males are attacked more frequently in the ratio of 8 to 5. This corresponds roughly to the sex distribution of all cases of gastro-intestinal carcinoma.

CLINICAL FEATURES

Mucoid carcinomata produce symptoms which differ little if at all from those of other gastro-intestinal malignancies. The rate of growth is slower consequently the symptoms develop over a longer period of time. Loss of

weight is perhaps not so marked, and intestinal hemorrhage with subsequent anemia is not common. The X ray examination does not differentiate the mucoid growth from other malignancies of the tract. The duration of symptoms apparently varies with primary or secondary origin of the mucoid character. When otherwise typical adenocarcinoma undergoes secondary mucoid change, the growth is slower and the duration of symptoms longer (average duration 10 months). When, on the contrary the mucoid substance is a primary character of the cancer with a predominance of signet ring cells, the carcinoma grows more rapidly and symptoms are more acute (average duration 5 months).

PATHOLOGY

Gross. The differentiation between primary and secondary mucoid changes in the tumor is better established by pathological study. One of these is a malignant hyperplasia of the mucus-forming elements and may be accurately termed *mucoid carcinoma*. The other is characterized by the development of mucous deposits in the presence of a pre-existing adenocarcinoma. It should therefore, for reasons which will be pointed out later be called *adenocarcinoma with mucoid degeneration*.

There is little difference in the gross characteristics of the two types. It is difficult to distinguish the mucoid deposits in the early stages. The tumor usually forms a small or circumscribed ulcer with raised edges and a dense induration invading the underlying intestinal wall. This may extend around the lumen of the intestine, producing varying degrees of constriction. There is no gross evidence of gelatinous deposits and the nature of the growth cannot be determined except by microscopic examination.

The tumor becomes thicker and more bulky in the next stage of development (Fig. 1). The surface is friable and contains translucent cystic areas of gelatinous material. These are of varying size and separated by a stroma, which is scant in the true mucoid carcinoma but more abundant and composed of adenocarcinomatous tissue in the degenerative type. These deposits are scattered throughout all

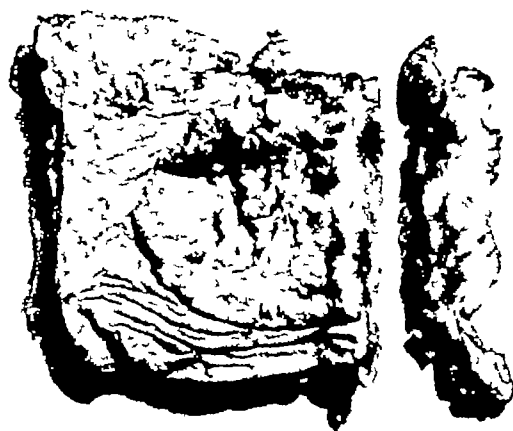


Fig 1 (P N 40102) Photograph of a mucoid carcinoma of the rectum. The growth is bulky and friable and had caused almost complete obstruction of the lumen. Minute gelatinous areas can be seen in the gross section. This is the earliest stage at which mucoid deposits can be recognized in the gross.

layers of the intestinal wall, but are largest in the deeper portions of the tumor.

The later stages are characteristic. There is an abundance of mucoid material producing, first, a bulky intraluminal growth and, later, extravasating to the subserosa, lifting the serosa to form grape-like clusters of gelatinous deposits surrounding the intestine and projecting into the peritoneal cavity, sometimes nearly filling it (Fig 2).¹ These extreme cases are more apt to occur in true mucoid carcinoma, and, on section of the growth, one can identify little else but the profuse deposits of mucin. The degenerative form of adenocarcinoma has a tendency toward less mucoid deposition and the solid part of the parent tumor is more in evidence.

Microscopic The histological appearance of mucoid carcinoma is characteristic. It is usually possible to demonstrate the presence of increased mucinous deposits by the ordinary hematoxylin-eosin stain. Specific stains for mucin, such as mucicarmine and mucin-hematein are more satisfactory when available. The technique for these methods can be found in any standard textbook for stain technology. The mucicarmine method was used in the study of this series.

¹In one case of this series, 6 quarts of friable mucoid material was scooped out of the abdomen at laparotomy for an inoperable carcinoma of the stomach.



Fig 2 (P N 11247) Photograph of a huge mucoid carcinoma of the stomach (autopsy specimen). The stomach walls are thickened by the tumor growth and the lumen is constricted. The gelatinous material formed a tremendous tumor surrounding the stomach and almost filling the peritoneal cavity. This is the advanced stage of the tumor.

Primary mucoid carcinoma Eighteen, or 14.6 per cent, of the 123 cases of this series were true mucoid carcinomata. The morphology is characteristic. Large amorphous, cystic areas of mucin are seen infiltrating the normal architecture of the intestinal wall. The mucus contains numerous shreds and a moderate amount of cellular detritus. The tumor invades the intestinal wall through the planes of least resistance. There is a proliferation of cells throughout the cystic areas. The majority of the cells are large and round with distended light staining cytoplasm. The nucleus is small in proportion to the amount of cytoplasm, is crescent shaped, and pressed to one side of the cell, forming the so called "signet ring cell" (Fig 3). Other cells are smaller, less distended, and the nucleus is round or oval. Parent

TABLE I — DISTRIBUTION

	Total carcinoma	Primary mucoid carcinoma	Adenocarcinoma mucoid degeneration	Total per cent
Stomach	245	11	18	11.8
Small intestine	14	0	2	14.3
Appendix	3	0	1	33.3
Colon	167	2	48	30.0
Rectum	166	5	36	24.1
Totals	595	18	105	17.7

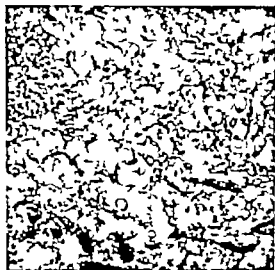


Fig. 3 (P.N. 3950) High power photomicrograph of mucoid carcinoma of the stomach showing an abundance of signet ring cells. The nuclei are compressed to one side of the cell and the cytoplasm is ballooned and distended with mucus. Small extravasations of mucus are beginning to accumulate about the cells.



Fig. 4 (P.N. 3713) Low power photomicrograph of mucoid carcinoma of the rectum. This shows the development of the signet ring cells from the parent tumor resembling medullary carcinoma. The parent tumor is youngest in the right side of the picture. Here polygonal cells can be seen in strands. Transition is taking place in the center and upper portion.

tumor cells can be seen in some areas of the tumor. These apparently arise from the epithelial cells of the mucosa, but do not retain their glandular arrangement (Fig. 4). They are large, round or polygonal, and have a moderate amount of cytoplasm and a hyperchromatic nucleus. There is evidence of active mitosis and proliferation in these parent cells, and this portion of the tumor resembles a medullary carcinoma. The cells break apart early and tend to grow independently.

The majority of these cells show a hypersecretion of mucus. All stages of development may be observed from this early type to the fully developed ballooned signet ring cell (Fig. 5). Undoubtedly cell degeneration takes place in the later stages of growth for fragments of signet ring cells and other cellular debris are frequently encountered.

A secondary infiltration of plasma cells and small round cells is found sometimes in the mucinous deposit sometimes in the surrounding stroma.

Metastases contain an identical type of tumor (Fig. 6). Mucus is abundant and

signet ring cells are numerous. No evidence of glandular formation can be found.

It is possible, therefore, to trace the development of the characteristic mucus-secreting tumor cell from the early malignant phase, through mitosis and increased secretory activity resulting in distention, extravasation, and, finally destruction.

Adenocarcinoma with mucoid degeneration. This type of tumor shows a secondary degenerative process and presents a variety of microscopical forms, dependent upon the degree of mucous formation and degeneration of the parent tumor tissue. The typical picture is that of adenocarcinoma. The undifferentiated cells grow downward into the submucosa and tunica muscularis, forming atypical tortuous crypts, similar to those in other forms of adenocarcinoma in the intestinal tract. In addition, there may be seen throughout the tumor small accumulations of mucus, which have no definite form and take a light stain with eosin. The earlier collections of mucus are found within the small acini of the crypts and resemble a normal secretion which

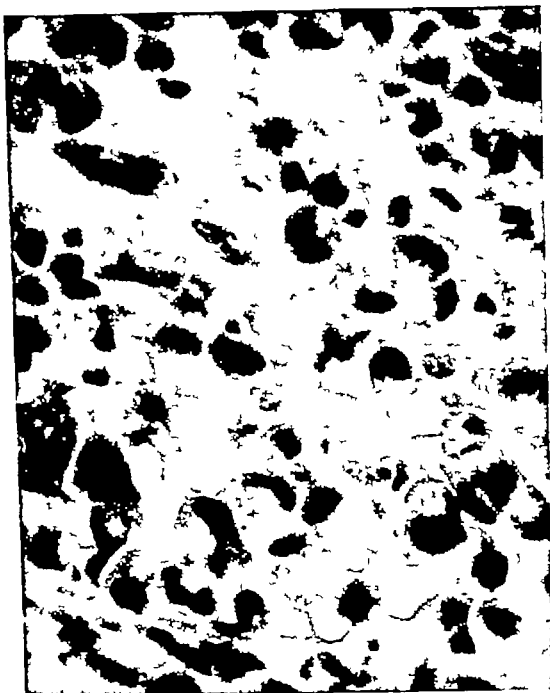


Fig 5 (P.N 37121) High power photomicrograph of mucoid carcinoma of the rectum (same case as in Figure 4) This illustrates the transition from the polygonal cell of the parent tumor to the distended signet ring cell with extrusion of mucus. Cell division can be seen in some of the cells.

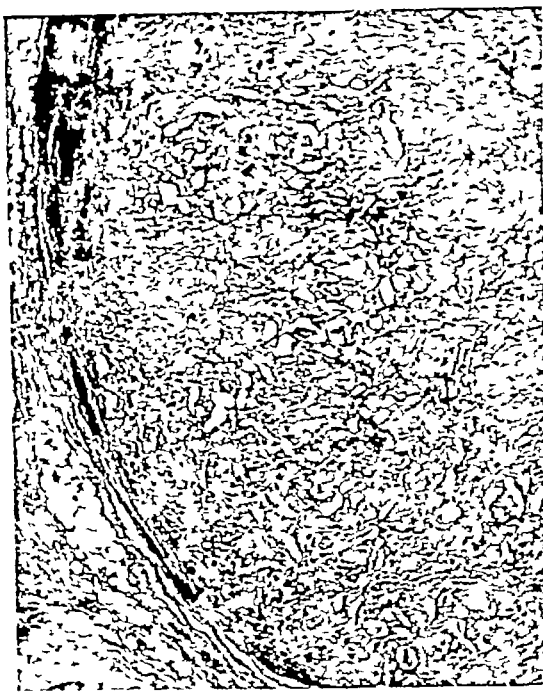


Fig 6 (P.N 37121) Low power photomicrograph of gland metastasis from a mucoid carcinoma of the rectum (same case as in Figures 4 and 5). This shows the tumor tissue almost completely replacing the lymphoid substance of the glands. Signet ring cells are abundant and the mucous deposits are like those of the primary tumor.

has not been allowed to escape into the lumen of the intestinal tract (Fig 7). The cells lining these crypts show active proliferation and no evidence of a regressive change. Larger areas of mucus are seen in a later stage of the same process (Fig 8). The secretion is more profuse. The crypt is distended and the epithelial lining is flattened, replacing the columnar shape of the cell by the smaller cuboidal form. A still later stage shows advancement of this process. The lining epithelium is fragmented and compressed by mucus and only a small portion of the cystic area retains its original lining. The remainder has been disintegrated as a result of pressure necrosis and its cells are scattered throughout the mucous area (Fig 9). Coincident with this rupture the mucus extravasates from the crypt and makes its way into the loose surrounding connective tissue. The advanced stage of the tumor then shows profuse ac-

cumulations of mucus, some retained in epithelium lined spaces and some breaking through this lining forming new cystic deposits, surrounded by false capsules of connective tissue (Fig 10). The picture is one of advanced degeneration with little evidence of cellular proliferation.

Such a process may be found in any grade of malignancy. In general, however, the production of mucus and subsequent degeneration of tumor cells in adenocarcinoma are inversely proportional to the grade of malignancy. This fact is illustrated in Table II. The largest deposits and the most profuse cell degeneration are found in the lower grade malignancy. It is not uncommon to find such degeneration in benign adenomata (Fig 11). In the more malignant tumors the differentiated mucus-secreting cells are fewer and their growth keeps pace with the secretion of mucus. All degeneration is, therefore, rare



Fig. 7. (P.N. 3 835) Low power photomicrograph of adenocarcinoma with mucoid degeneration. This illustrates the earliest stage in the formation of the tumor. In the lower part of the picture the mucus is being secreted in the smallest acid without degeneration of the cells. The larger cystic deposits near the center of the picture show a more advanced stage.



Fig. 8. (P.N. 3 835) Low power photomicrograph of adenocarcinoma (Grade III) with mucoid degeneration. This illustrates the small accumulation of mucus in adenocarcinoma of higher grade. The strands of tumor tissue in the upper portion of the picture show no evidence of mucus secretion.

and occurs late in the course of growth, if at all.

Metastasis is common in the more malignant grades of adenocarcinoma. The appearance of mucus in the metastasis is less common and occurs late.

PATHOGENESIS

Most authors agree that carcinomata of the mucous variety are composed largely of atypical mucoid deposits arising from secreting cells of the mucosa. This belief is upheld by the occurrence of such deposits in locations where these cells are common by the microscopical evidence of secretory activity and finally by the chemical analysis of the mucin. Wells describes this material as a compound protein composed of a protein radical and a conjugated sulphuric acid. It is slightly acid in reaction and is basophilic in its staining properties. It is soluble in weak alkalis and may be precipitated by acetic acid.

In discussing the origin and nature of the tumor it is essential further to consider the types separately

Mucoid carcinoma The origin of the mucoid carcinoma characterized by an abundance of mucus a preponderance of signet ring cells, and the absence of a lining epithelium is a mooted question. Staemmler believes that a similar type can arise as a degeneration product of medullary carcinoma. Ziegler has stated that a type of myxoma can arise from the connective tissue of the submucosa and may be confused with colloid carcinoma. Myxomatous tissue differs from mucin chemically however in its protein and phosphorous content. The results of this study support the theory of Staemmler. The characteristic cell takes its origin from a parent tumor tissue, arising from the epithelial cells of the mucosa and resembling the earliest form of medullary carcinoma. These cells grow in strands and sheets, but do not retain the glandular form of adenocarcinoma. On the contrary the cells soon separate and proliferate independently. Coincident with this separation, the cells are stimulated to a hypersecretion of mucus. The cytoplasm becomes distended and more granular. The nucleus in this phase



Fig 9 (P N 34260) Low power photomicrograph of adenocarcinoma with mucoid degeneration, showing late stage of secretion with marked degeneration of the tumor tissue. The mucus has ruptured the epithelial lining of the cystic structures and is infiltrating the surrounding stroma profusely.



Fig 10 (P N 33633) Low power photomicrograph of adenocarcinoma (Grade I) with mucoid degeneration. Advanced stage of mucous secretion in which the parent tumor tissue is markedly degenerated and entirely surrounded by profuse areas of mucus.

becomes compressed, pushed to one side of the cell, and eventually flattened, so that it assumes the characteristic signet ring shape. Practically all of the cells eventually show this change. The next phase is an extravasation of mucus from the cell, forming extracellular deposits, at first small, becoming larger as the tumor progresses until the tumor cells float free in areas of mucus, without, however, any decrease in their viability. That the cells retain their power of reproduction is indicated by frequent mitotic figures in the signet ring cells. This is further shown by the fact that these cells metastasize in this form, and, in the secondary growths, the tumor consists entirely of individual cells of this type.

Adenocarcinoma with mucoid degeneration

Divergent opinions have been proposed regarding the origin of the adenocarcinoma with mucoid degeneration, most of which center about the process of degeneration. Some investigators regard the presence of mucus as the result of degeneration in the epithelium. This view is held by Prudden, Councilman, and others. Ohlacher compares it to other types of degeneration occurring in the body,

such as hyaline and amyloid changes. The more recent view held by Adams, Gaylord and Aschoff, Ziegler, and Stinson is that of a hypersecretion of the epithelial cells, but does not clarify the relation between the mucous secretion and the degeneration. Both views are apparently based on the fact that cell degeneration and mucoid deposits are practically always found together. The controversy is, therefore, reduced to this: Is the degeneration a cause or an effect of the mucus? The present study indicates that the degeneration

TABLE II—MALIGNANCY AND DEGREE OF MUCOUS FORMATION AND DEGENERATION

Grade of malignancy	Degree of mucous formation and cell degeneration				
	1	2	3	4	Total
I	0	16	22	12	50
II	11	13	9	1	34
III	7	10	1	0	18
IV	3	3	0	0	6
Total	21	42	32	13	108



Fig. 1 (P.N. 43707) Low power photomicrograph of benign adenoma with mucoid degeneration. The picture is similar to that of any malignant tumor with hypersecretion of mucus, causing rupture and degeneration of the epithelial cells and extravasation into the surrounding tissue.

is a direct result of the mucous secretion. This belief is supported by the following facts:

1. The degree of degeneration parallels closely the degree of mucous secretion and there is no evidence of degeneration in the earliest deposits.

2. Degeneration is not common in the absence of mucin or other abnormal factors.

3. Mucous secretion and subsequent degeneration have been observed in benign adenomata, showing that mucous deposits do not necessarily indicate malignancy.

4. It is possible to produce a similar picture with accumulations of mucus and subsequent flattening and degeneration of the epithelium in experimental animals.¹

The mucous deposits, therefore, can be regarded as retention cysts or mucocysts, which are brought about by the inclusion of mucus-secreting epithelium within the substance of the tumor leaving no outlet for the products of secretion. The question at once arises as to



Fig. 2 (P.N. 43804) Low power photomicrograph of adenocarcinoma (Grade IV) with mucoid degeneration. This illustrates the small amount of mucus in the presence of tumor of higher malignancy. The mucus has extended beyond the tumor tissue, but the tumor cells are still in an active stage of growth and show little degeneration.

why mucus does not occur in every adenoma. This can be explained by the fact that all tumors do not possess differentiated mucus-secreting cells. Those whose epithelial components contain these cells do eventually give rise to accumulations of mucus.

The malignancy of the parent tumor therefore, is not altered by the presence of mucus as is commonly thought but corresponds in degree to that shown by adenocarcinoma of the same grade.

PROGNOSIS

The degree of malignancy and consequently the prognosis is widely different for the two types previously discussed. As has been stated, those tumors associated with degeneration show the same degree of malignancy as an adenocarcinoma of the same grade,

¹A small, wedge shaped flap of the wall of the colon of a cat was resected and brought up subcutaneously through the abdominal wall and pinned in place. The blood supply was preserved and the flap exposed to secretory sources. After six days the animal was sacrificed and the abdominal wall sectioned. Mucous tubes through the area including the flap, showed dilatation of the crypts, with accumulation of mucus, flattening and degeneration of the epithelium.

without mucous formation. Consequently, the prognosis is comparable to that of pure adenocarcinoma and depends largely upon the duration of the tumor, its growth, and presence of metastases.

True mucoid carcinoma on the other hand, is more malignant. The cells retain their ability to proliferate in spite of the hypersecretion of mucus and degeneration is less common. Metastases occur earlier and grow more rapidly. It is also more difficult to remove the tumor entirely and peritoneal implants are frequent. These features can be appreciated best by reference to Table III, which shows the results of treatment in this group. This group includes only those cases in which the patient survived operation and upon which definite follow-up data is obtained. Only 18 per cent of the true mucoid carcinomata have remained well over 5 years, or if operated upon within the past 5 years, are living at present without sign of recurrence. Adenocarcinomata with mucoid degeneration, on the other hand, show 5 year cures in 56 per cent of the cases. These figures indicate clearly that the first type of tumor is far more malignant and the prognosis relatively poor. Radical operation, however, with tumors of the latter type give more satisfactory results and, if the immediate effects of the operation are survived, the chances of recovery are good.

Of those dying ultimately from recurrence, it is interesting to note that the span of life following operation is longer in cases of adenocarcinoma with mucoid degeneration than with true mucoid carcinoma.

CONCLUSIONS

1 The term "colloid carcinoma" is not favored, since it does not indicate the true meaning of the tumor. Mucoid carcinoma has been adopted in its place as a more accurately descriptive term.

2 One hundred and twenty-three cases have been studied in this series both from the standpoint of pathology and ultimate results.

3 Mucoid carcinomata are divided into two distinct groups, one the *true mucoid carcinoma* arising as a tumor of mucus-secreting

TABLE III—RESULTS OF TREATMENT IN 41 CASES

	Cases	Per cent
Primary mucoid carcinoma		
Well 5 years or living at present	2	18
Dead ultimately from effects of tumor	9	82
Adenocarcinoma with mucoid degeneration		
Well 5 years or living at present	23	56
Dead ultimately from effects of tumor	18	44

cells and the other *adenocarcinoma with degeneration*, a degenerative product of simple adenocarcinoma.

4 The degree of mucus formation in adenocarcinoma is, roughly, inversely proportional to the grade of malignancy.

5 Mucous deposits do not necessarily indicate malignancy as they have been found in benign adenomata and have been produced experimentally in animals. The mortality of adenocarcinoma with mucoid degeneration parallels that of simple adenocarcinoma. The mortality of true mucoid carcinoma is much higher (82 per cent), and in all probability is due to its rapid growth, early metastases, and a tendency to form implantations.

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VISCERAL PAIN¹

LOYAL DAVIS, M.D. F.A.C.S., LEWIS J. POLLOCK, M.D. AND THEODORE T. STONE, M.D., Chicago

THE term "visceral pain" usually is restricted to the description of that pain which occurs in or is produced by changes in the state of intrathoracic, intra-abdominal, or intrapelvic organs. In addition certain clinical observations have pointed to the possible existence of a type of pain occurring in the extremities and head which is not mediated by the ordinary somatic nerves. Section of the posterior roots for the relief of certain painful conditions such as gastric crises, causalgia, and amputation neuromata has not been uniformly successful.

Based upon these clinical observations two conceptions of a pathway for the transmission of visceral pain other than by the posterior roots have been developed. The first deals with a possible antidromic sensory fiber in the anterior roots. At various times since Claude Bernard (3) concluded that recurrent sensory fibers passed from the posterior root ganglion through the anterior root the validity of the Bell-Magendie (2) law has been questioned. Among the proponents of the theory that sensory impulses travel antidromically over the anterior root are Leonard Kidd (22), Lehmann (25), Kodama (23) and Shaw (37). In 1911 Foerster (12) whose important authority rests upon careful studies of a very large number of posterior root sections for the relief of many different disabilities, came to the conclusion that the anterior roots subserve an auxiliary function in relation to a special kind of deep sensibility of the subcutaneous and visceral structures. Although their section is not followed by demonstrable sensory loss, he believes that the anterior roots are capable of carrying a certain type of sensibility varying in degree in each individual when the posterior roots are severed.

In strong confirmation of this conception, Foerster, Altenburger and Kroll (13) reported that in one case the thoracic sympathetic chain was resected from the sixth to the tenth ganglion. During this operation the ninth thoracic nerve was ligated close to its

exit from the intervertebral foramen. This produced severe pain. At the same time the adjacent intercostal artery was ligated. The pain persisted. At a subsequent operation the seventh to eleventh thoracic posterior roots were resected. Despite this the pain continued. The authors concluded that the painful stimuli could have entered the spinal cord only by way of the anterior roots.

In a former communication (10) two of us reported that in an extremity completely deafferented by section of a sufficient number of posterior roots, no form of sensibility could be produced by any type of stimulus applied cutaneously or subcutaneously. Although the decerebrate animal is particularly sensitive to all forms of nociceptive stimuli, when the lumbosacral plexus was severed in a number of decerebrate cats, no reflex activity could be elicited from the denervated extremity. After complete deafferentation of the upper extremity likewise no reflex activity could be elicited from that extremity. This indicated that sensory impulses passed only over the ordinary spinal nerves and the posterior roots.

With particular reference to the intra-abdominal viscera, Lehmann found that pain could be produced by digital pressure on the gall bladder of a dog after section of the fifth to ninth thoracic posterior roots. Later when he severed the fifth to ninth anterior roots, no evidence of such pain could be elicited. Kodama was able to produce pain by pressure upon the liver gall bladder and branches of the aorta after section of the fourth thoracic to second lumbar posterior roots bilaterally and extradurally. On the other hand Davis, Hart and Crain (6) found that the evidence of pain produced by dilatation of the gall bladder could be abolished by section of a sufficiently large number of posterior roots. Two of us likewise found that no reflex activity could be evoked in a decerebrate animal by stimulation of the right splanchnic nerve, after section of the thoracic posterior roots, although this type of stimulation produces

violent responses in an otherwise normal decerebrate animal. After posterior root section, Spiegel and Bernis (40) were unable to find evidence of pain or reflex activity when the central end of a severed splanchnic nerve was stimulated. Recently, Stone (41) reported that after section of the thoracic and the first lumbar anterior roots, stimulation of the gall bladder by distention produced pain. On the contrary, after section of the corresponding posterior roots distention of the gall bladder did not produce pain. We believe, therefore, that whatever the mechanism of visceral pain, the painful impulses enter the central nervous system by way of the posterior roots.

The second conception which has originated concerning visceral pain is that in addition to the ordinary somatic afferent pathways, the sympathetic nervous system may carry visceral sensory impulses, along peri-arterial plexuses to the sympathetic ganglionic chain and from there enter the spinal cord (Foerster, Altenburger, and Kroll). Likewise, the failure of section of the posterior root of the fifth cranial nerve to relieve certain so called atypical facial neuralgia has called attention to the possible rôle played by the sympathetic nervous system in the production of pain. Therefore, attempts have been made to relieve such pain by injections into the sphenopalatine ganglion (Sluder, 38), by excision of Meckel's ganglion (Cushing, 7), (Frazier, 14), or by section of the various branches of the superior cervical sympathetic ganglion.

The importance of this pathway for the transmission of visceral pain has been emphasized also by the relief of other types of pain by various surgical operations on the sympathetic nervous system. The pain of angina pectoris has been relieved by the removal of the middle, inferior cervical, and first thoracic ganglion of the left sympathetic chain by Jonnesco (19). Coffey and Brown (6) have obtained somewhat similar results by sectioning the sympathetic trunk and the superior cardiac nerve below the superior cervical ganglion or by excising this ganglion. Successful results have been reported from essentially similar operations by Bruening (5), and even more extensive operations have been advocated by the more recent studies of

Braeucker (4), and Jonnesco and Enachescu (20). Mandl (31) and Swetlow (42) and White (45) have attempted to relieve the pain of angina pectoris by blocking the rami communicantes with paravertebral injections of alcohol. Likewise, abdominal pains have been relieved by von Gaza (15), Scrimger (36), and Archibald (1) by section of the abdominal sympathetic nerves. The sacral portion of the sympathetic trunk has been resected for the relief of pain in inoperable carcinoma of the uterus. The relief of pain from causalgia, painful amputation stumps, and other conditions by peri-arterial sympathectomy has been widely reported by a large number of observers following the work of Leriche (28).

Although pain may be produced by stimulation of certain parts of the sympathetic nervous system and relieved by severance of suitable parts of the sympathetic nervous system, there is no agreement as to the manner in which the pain is produced. With regard to the possible afferent fibers in the sympathetic nervous system which carry painful impulses from the extremities to the spinal cord, we may say that no contralateral reflexes could be elicited from the completely denervated extremities of decerebrate cats, nor could pain be produced by any type of subcutaneous or cutaneous stimuli in the completely deafferented extremity of man. This leads us to conclude that there is no evidence of an auxiliary sensory supply by the sympathetic nervous system in the extremities of cats or man.

The mechanism of pain originating from intra-abdominal organs is more difficult to study. Soon after the development of the operation of colostomy, it was observed that the colon was insensitive to cutting, pricking, or burning. To explain this, Lennander (27) assumed that the abdominal viscera were entirely devoid of sensory nerves capable of producing pain and that all painful sensations from disease of intraperitoneal organs originate in the parietal peritoneum and its subserosa layer which is richly supplied with cerebrospinal sensory nerves. This idea was definitely disproven by Neumann (33), and Kast and Meltzer (21). A few years earlier, James Ross (34) set forth his view that there

are two kinds of pain in the disease of internal organs first a true splanchnic pain which is felt in the organ giving rise to afferent stimuli and second an associated somatic pain which is felt in that part of the body wall which is connected by cerebrospinal nerves with the same segments of the cord as the affected splanchnic nerves. In respect to the associated somatic pain he said 'when the splanchnic peripheral terminations of the fourth, fifth, and sixth thoracic nerves are irritated the irritation is conducted to the posterior roots of the nerves, and on reaching the gray matter of the posterior horns it diffuses to the roots of the corresponding somatic nerves and thus causes an associated pain in the territory of distribution of these nerves which may appropriately be named the somatic pain. Although this theory of referred pain is ordinarily attributed to Rose Lange (24) stated long before that all pain in visceral disease was of purely reflex origin. He traced the impulses through the afferent fibers of the vegetative nervous system to the spinal cord where he believed that radiation occurred along the sensory nerves to the abdominal wall. Mackenzie (30) was much impressed with the significance of Roes somatic, or referred, pain but was doubtful of the existence of splanchnic pain since he believed that the viscera are supplied with afferent splanchnic fibers, he did not believe that visceral painful impulses transmitted through these nerves to the central nervous system reach consciousness. He found areas of cutaneous hyperalgesia in cases of visceral disease and contraction of the muscles of the abdominal wall due to disease of an abdominal organ. From these observations he described the symptoms of pain and hyperalgesia in consequence of disease of the viscera as a "viscerosensory reflex and the contraction of the muscles as a "visceromotor reflex. Head (17) unlike Mackenzie, supported Rose's view of splanchnic or visceral pain. He believed that although visceral pain was for the most part referred there was, in addition, a low form of protopathic pain which represented true visceral sensation. From his study of a series of cases of herpes zoster he mapped out the somatic areas along which

pain was referred in visceral disease. The view that the viscera themselves were insensitive to painful stimuli finally was refuted completely by Hurst (18) who attached great importance to the work of Kaut and Meiner. Hurst pointed out that the viscera were sensitive only to appropriate stimuli and although they may be cut, pinched, or burned without pain, increased tension on their muscular wall produced true visceral pain. We now know that visceral afferent impulses may appear as consciousness as a painful sensation and that at least in the stomach or intestines there is also a crude form of temperature sensibility.

Recently the mechanism of the referred or somatic type of visceral pain has been investigated from several angles. From a careful clinical study Morley (32) is convinced that true visceral pain exists and that it is usually the result of abdominal tension on the walls of the hollow viscera. It is in no sense referred to the superficial structures of the abdominal wall and is a deep seated central pain not accurately localized. He believes that the phenomena of deep and superficial tenderness and muscular rigidity of the abdominal wall observed in association with inflammatory disorders in the abdomen are entirely referred from the highly sensitive cerebrospinal nerves to the parietal peritoneum. In this process two closely related mechanisms are concerned which he describes as "peritoneocutaneous radiation" or the "peritoneomuscular reflex. In support of this theory he refers to the shoulder tip pain of diaphragmatic origin as a striking example of referred pain. In this instance he says there is no question of a viscerosensory reflex. He believes that the rest of the parietal peritoneum lining the abdominal wall resembles the peritoneum lining the diaphragm. It differs only in that each spinal segment which supplies a strip of parietal peritoneum also supplies a strip of overlying skin. The pain produced by stimulation of this parietal peritoneum is referred or radiates to the superficial structures exactly as in phrenic shoulder tip pain and is not appreciated as arising in the parietal peritoneum at all. Morley compares the radiation of such pain to the spreading of pain from a carious tooth to the skin of

the cheek or to the neighboring teeth. In both cases a stimulus applied to a limited portion of a somatic sensory nerve gives rise to pain and tenderness in a wider and more superficial extent of the same nerve. "There is here no question of the highly doubtful hypothesis of a radiation of pain from the splanchnic to the somatic system of nerves. Whether the afferent arc producing a sensory reflex is composed of the splanchnic nerves or the sensory cerebrospinal nerves, the other components of this reflex are unknown." Morley says that Ross' theory of referred pain is very attractive and suggests an alternative but very similar explanation which would place the "focus of irritation" not in the posterior horns but in the posterior root ganglia. This is the view taken by Lemaire (26).

The question of the mechanism of this referred pain has been stimulated further by the report of Danielopolu and Hristide (8) of the cessation of anginal pain by the alcoholic injection of the second and third intercostal nerves. They believe that the degenerative changes in the posterior root ganglia cells prevent afferent impulses from passing through the split ganglionic fibers. Spiegel (40) and Hashimoto (16), however, were able to produce pain by stimulation of the stellate ganglion after sufficient time had elapsed after the section of the brachial plexus and first to fourth intercostal nerves to permit degeneration to occur. However, it may be said that their experiment would have been more conclusive had the stimulation been produced by such a method as dilatation of the aorta.

Impressed by this work, Lemaire produced local anæsthesia of the entire abdominal wall and later of only the subcutaneous tissues and observed a disappearance of pain, tenderness, and rigidity of the abdominal wall in patients suffering from various intra-abdominal diseases. From these observations he concluded that the visceral stimulus must be referred not through the spinal cord but through the bipolar cells of the posterior root ganglia. Weiss and Davis (44) anæsthetized the skin into which pain was referred in twenty-five patients suffering from various diseases, such as angina pectoris, pleuritis, carcinoma of the

œsophagus, gastric ulcer, cholecystitis, nephrolithiasis, acute appendicitis, salpingitis, and pyelitis with either complete relief of the pain or relief to a large extent. They also were able to prevent the occurrence of pain due to distention of the œsophagus or duodenum by a balloon. They believed that this was added proof of the truth of Mackenzie's viscerosensory reflex. Morley, however, insists that although these observations are correct they support his theory of a peritoneocutaneous radiation rather than a viscerocutaneous reflex. He repeated these experiments in a series of thirteen patients suffering with acute abdominal lesions and was able to confirm Weiss and Davis' findings. Woolard, Roberts, and Carmichael (46) attack Morley's conception based on shoulder tip pain because they failed to stop the pain by anæsthetization of an area of skin over the shoulder. We believe the area anæsthetized by these investigators was not sufficiently extensive to have constituted a crucial experiment. Lugaro's (29) contention is that because of the cutaneous analgesia there is a diminution in the number of excitations traveling toward the central area of pain. Verger (43) states that the algogenetic stimulus from the viscera produces a vascular reflex with a modification in the vascular bouquet of the skin which excites the sensory corpuscles from which the impulses travel over the sensory cerebrospinal nerves through the posterior roots. A somewhat similar theory is proposed by Spameni and Lunedei (39) who state that the visceral impulses which reach the lateral columns of the cord by afferent pathways here stimulate centrifugal unmyelinated fibers which terminate in the sensory corpuscles. Physicochemical changes are thus produced which stimulate the sensory organs from which impulses travel over the cerebrospinal nerves. The last two theories have much to commend them and lend themselves well to experimental proof.

Without having read the work of Verger and Spameni and Lunedei, we stated in a former communication (11) that stimulation of the superior cervical sympathetic ganglion produces an effect which is carried by way of postganglionic efferent fibers to structures

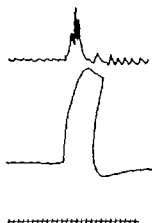


Fig. 1. Effect upon respiration of distention of the gall bladder in a normal animal.

innervated by sympathetic fibers. These efferent impulses produce an effect in the skin and other structures the exact nature of which we are unable to state. It is possible that it is linked with the sympathetic innervation of the blood vessels and that a metabolite is released which in turn stimulates the ordinary sensory nerve endings of the fifth nerve. This impulse is then transmitted centrally and is recognized as pain.

This conclusion was reached from a series of experiments in which we showed that faradic stimulation of the cervical sympathetic trunk does not produce pain; that stimulation of the superior cervical sympathetic ganglion does produce pain; that stimulation of this ganglion after section of the anterior spinal roots produces pain; that stimulation of the ganglion after section of the posterior spinal roots produces pain; that stimulation of the ganglion produces pain after section of the anterior spinal roots and fifth cranial nerves, but that the pain disappeared upon stimulation of the ganglion after the posterior spinal roots and fifth cranial nerve were sectioned. Inasmuch as only efferent postganglionic fibers are present in the cervical sympathetic trunk it is obvious that after the cerebrospinal nerve root section, the only possible pathway is by way of the efferent sympathetic to some mechanism which stimulates the sensory end organs of the

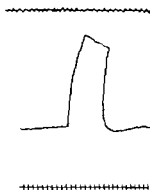


Fig. 2. Abolition of respiratory response and pain following section of the right splanchnic nerve.

fifth nerve producing ordinary cerebrospinal pain. This conforms with the pathway as proposed by Verger who places the sympathetic efferent fibers in the posterior root as antidromic conductors and with the description by Lugaro of a centrifugal non-myelinated fiber in the posterior root. The relief of pain of visceral disease by blocking or severing the intercostal and abdominal nerves is therefore of great interest in this respect.

Continuing our studies upon sensation we performed a number of experiments to determine whether painful responses to distention of the gall bladder persisted after the overlying thoracic and abdominal wall was rendered analgesic by section of the intercostal nerves. Cats were used as the experimental animal. The gall bladder was distended by introduction of water into a tube leading to a balloon which had been inserted into the gall bladder at a former operation. The water was inserted by a syringe connected by a T tube, one end of which led to the balloon and the other end to a glass tube which penetrated a rubber cork inserted into a flask. To the end of the tube within the flask was attached a rubber bulb which acted as a valve. From the flask another tube led to a Marey recording tambour which registered the relative pressure and time of the application of pressure. Respiratory tracings were obtained by an air system pneumograph which recorded by a Marey tambour.

In one series of fifteen animals the intercostal nerves were sectioned on the right side

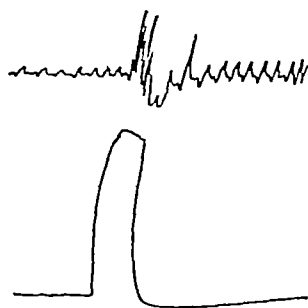


Fig 3 Persistence of respiratory responses and pain after section of the left splanchnic nerve

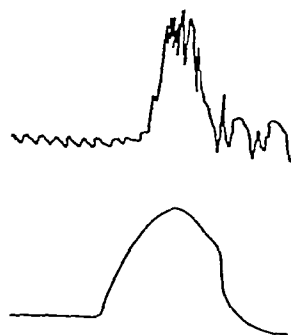


Fig 4. Section of the thoracic and first lumbar anterior roots fails to abolish pain produced by distention of the gall bladder

under ether anaesthesia. In each instance twelve to fourteen nerves were sectioned as close as possible to the transverse processes of the vertebrae. The skin incision paralleled the spinal column and the nerves were isolated just beneath the costal margins without entering the pleural cavity. In a second series of five animals which were anaesthetized by the intravenous administration of 15 to 2 grains of nembutal the thoracic cavity was opened and the intercostal nerves were sectioned close to the rami communicantes. This operation was carried out under artificial respiration administered through a tracheal catheter. This series of animals was operated upon in this manner to rule out the possibility of the transmission of pain to the subcutaneous tissues through the short stumps of the intercostal nerves left in the preceding type of operation.

Forty-eight to seventy-two hours later the gall bladder was exposed and since the skin was insensitive no anaesthesia was necessary. Without exerting traction on the gall bladder, a purse string silk suture was placed in the fundus. The gall bladder was opened, the rubber balloon and tube were inserted and the suture tied. The closure was made secure and the wound closed in layers with the open end of the tube brought to the outside. After the animals had recovered perfectly the experiments were carried out.

When the gall bladder of a cat is distended it has been found by Schrager and Ivy (35), Davis, Hart and Crain, and Stone that evidence of pain as shown by struggling, outcnes, respiratory and other reflexes occurs. In the course of this work we were able to confirm this and show that the usual respiratory inhibition is often masked by the movements produced by struggling. Kast and Meltzer called attention to many reflexes not associated with pain which occur as the result of stimulating the viscera. They used as an indication of pain, movements of the tail, struggling, crying, and respiratory changes which occurred coincidentally with stimulation and ceased after it. These criteria we have followed (Fig 1). These authors found that section of the right splanchnic but not the left abolished such painful responses. We have repeated these results and are able to confirm them. Figure 2 illustrates the abolition of respiratory response and pain following section of the right splanchnic nerve upon dilatation of the gall bladder. Figure 3 illustrates the persistence of respiratory responses and pain after section of the left splanchnic nerve.

As one of us has already reported, section of the anterior roots does not abolish evidence of pain or respiratory change upon distention of the gall bladder. This indicates that no antidromic fibers in the anterior roots sub-

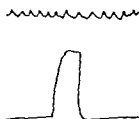


Fig. 5. Section of posterior roots abolishes pain produced by distention of the gall bladder.

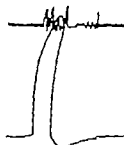


Fig. 6. Persistence of pain after section of intercostal nerves.

serve exclusively painful impulses produced by distention of the gall bladder in cats. The anterior roots do not carry the sympathetic afferents included by Verger in his theory but they must if they exist as illustrated in his diagram, run antidromically in the posterior roots. Figure 4 illustrates the failure of section of all the thoracic and first lumbar anterior roots to abolish pain produced by distention of the gall bladder.

As already described by Davis, Hart, and Crain section of a sufficient number of posterior roots abolishes all pain and reflex activities normally produced by distention of the gall bladder (Fig. 5). It has been shown abundantly that when the skin overlying the gall

bladder in man is rendered analgesic the pain of gall bladder colic is relieved. The intercostal nerves of twenty cats were severed just distal to the rami communicantes. Distention of the gall bladder in these animals was followed by persistence of the respiratory reflexes, and there were other evidences of slight pain such as crying and struggling movements. This would indicate that if any referred pain occurs in cats as the result of distention of the gall bladder and the referred pain as in man could be abolished by analgesia of the area into which the pain is referred, then pain independent of referred pain, namely true visceral or splanchnic pain, exists in cats (Fig. 6). Believing that perhaps

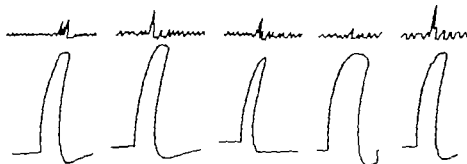


Fig. 7. Persistence of pain after section of (a) the intercostals, and then successively (b) phrenic, (c) brachial plexus, (d) sympathetic trunk, and (e) vagus.

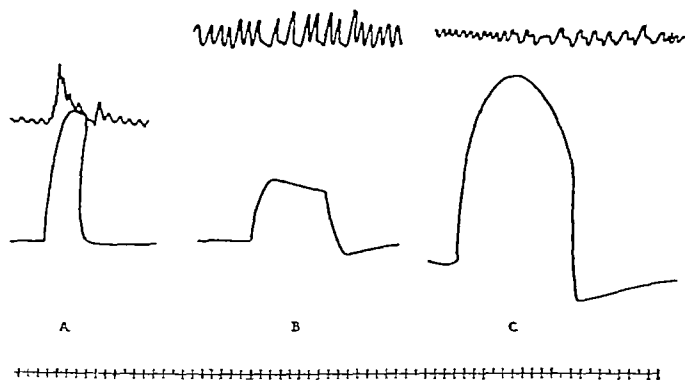


Fig 8 Comparison of responses obtained by distention of the gall bladder in a normal animal and in two animals with the intercostal nerves cut.

the pain may be referred possibly through the phrenic nerve it was sectioned along with the intercostals and then successively the brachial plexus, the cervical sympathetic trunk, the stellate ganglion and the vagus nerves were sectioned. Pain persisted after each of these procedures. This indicated that the visceral afferent impulses traveled by way of the right splanchnic nerve alone (Fig 7). Another observation which is, however, not so crucial is that the character of the response to stimulation by distention of the gall bladder after section of the intercostal nerves was modified in that the struggling was very slight and often respiratory inhibitions could easily be seen accompanied, however, only by a slight struggling. It was likewise observed that a greater distention was necessary than in the

otherwise normal animal. We may be permitted to speculate that the pain elicited by distention of the gall bladder in cats is possibly diminished and perhaps changed in character by section of the intercostal nerves (Fig 8). It becomes necessary to devise another experiment which will be crucial for the study of referred pain in cats.

Of interest in this connection is the action of nicotine upon the pain produced by distention of the gall bladder. Following injection of 0.1 milligram per kilogram, marked hyperpnea occurred for several minutes. When the gall bladder was distended no respiratory reflex occurred and no evidence of pain was observed. However, when the toes

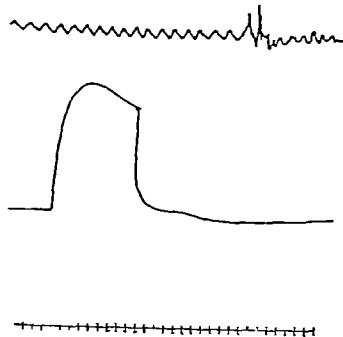


Fig 9 Persistence of response to nociceptive stimuli to foot and abolition of responses from distention of the gall bladder after the administration of nicotine.



Fig 10 Recovery of respiratory and painful responses to distention of the gall bladder forty-two minutes after the injection of nicotine.

were pinched struggling and crying occurred as shown by the respiratory tracing. After a varying time had elapsed respiratory responses and pain were again elicited by distention of the gall bladder. Figure 9 shows the persistence of the response to nociceptive stimuli applied to the foot and the abolition of responses from distention of the gall bladder after the administration of nicotine. Figure 10 illustrates the recovery of the respiratory and painful responses to distention of the gall bladder forty two minutes after the injection of nicotine.

When a preparation may be conceived in which referred pain only may be produced, continued studies with nicotine may serve further to elucidate this difficult problem.

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ANHYDRÆMIA AS A POSSIBLE CAUSE OF DEATH IN LIVER AUTOLYSIS

EDWARD C. MASON, M.D., Ph.D., AND CECIL W. LEMON, A.B., M.D., OKLAHOMA CITY, OKLAHOMA
From the Department of Physiology, University of Oklahoma School of Medicine

IN 1925 Mason and Davidson published a series of studies (5, 6, 7) on the subject of tissue autolysis *in vivo*, the object being to determine the cause of death which results when fresh liver tissue is left free within the peritoneal cavity of a dog. The subject has since stimulated considerable interest and the research of others has contributed greatly to our knowledge of the problem. Our original experiments were criticized on the assumption that the procedure killed the dogs by producing peritonitis, but Andrews, Thomas, and Schlegel repeated part of the work and in 1928 reported results which agreed with our findings.

Ellis and Dragstedt again opened the subject in 1930 and concluded that death of the animals operated upon was due to a severe peritonitis set up by a bacillus similar to the *Bacillus welchii* organism. The source of the infection being the sectioned liver, the bacteria remaining in a latent state until stimulated to activity by the asphyxiation of the liver tissue. We do not deny the presence of the anaerobic bacillus, however, we (8) do not believe the authors have sufficient evidence on which to base their claims. They killed some of their animals at the end of 15 to 38 days and demonstrated the presence of the organism which they claim causes the death

of our animals in 15 to 18 hours. They also showed that fetal liver, both sterile and infiltrated with the anaerobic organism, failed to kill the dogs.

Recently Andrews and Hrdina (2) have conducted a series of experiments to analyze the mechanism of this peritonitis. They again called attention to the fact that death occurred generally within 20 hours following the operation, and therefore, it seems inconceivable that a pure infection could be responsible for the death. In their autopsy records they stated, "We have a picture of a severe toxic reaction and not of a severe infection." They have introduced the term "autolytic peritonitis" to express the pathological finding. The following appears in their conclusions: (1) "In *in vivo* autolysis of liver, death is due to a condition described as autolytic peritonitis. That is, a toxic reaction characterized by hæmorrhages into the peritoneum with production of much fluid and overwhelming infection with gas bacilli." (2) This reaction can be provoked by the implantation of sterile material."

The first paper (5) published on this subject contains the following pathological report: "On postmortem examination the abdomen usually contains 100 to 300 cubic centimeters of brown colored fluid but in no

case did the fluid appear to be actual blood. A pseudofibrinous exudate is usually present, it being different from a true fibrinous exudate in that it is easily removed, leaving a smooth shining surface a small amount of such exudate is usually present over the dome of the liver and often intestine loops are loosely adherent to each other. The intestines are generally hyperemic with marked congestion. The omentum is well wrapped about the free piece of liver the omentum being markedly hemorrhagic and discolored. The picture is similar in many ways to that of peritonitis. However in no case was there any indication of a septic peritonitis and such peritonitis as is present should doubtless be considered as chemical.

After reviewing the various studies made on this subject, we are forced to consider three possible factors as the cause of death in these experimental animals. The first factor is the toxic substance generated in the autolyzing liver. It was this substance which we first studied and demonstrated to be very toxic. We observed that it required only 7 to 8 cubic centimeters of a salt extract, administered intravenously to produce instant death. The second factor was emphasized by Ellis and Dragstedt who called attention to the Welch-like bacilli. However a pure culture of such organisms injected into the peritoneal cavity does not produce a condition comparable with that accompanying liver autolysis. The third factor is that of anhydremia. This possibility was considered in our first study in which we reported a decreased plasma volume, decreased serum volume, and an increase of fibrin content. We have constantly observed free fluid in the peritoneal cavity and this observation has subsequently been reported by others however the possible relation of the free fluid to the condition has not been discussed. In our earlier work, we reported that postmortem examination revealed 100 to 300 cubic centimeters of brown colored fluid in the abdomen, while the report of Andrews and Hrdina states that the abdomen contains 300 to 500 cubic centimeters of exudate. If the source of this fluid is the circulating blood, it would represent approximately one-third to one-half of the total blood volume. Review-

ing our previous observations, we note a constant and pronounced fall in blood plasma volume following the operation. There is likewise a marked fall in serum volume and the percentage of fibrin in the blood is greatly increased. All these changes indicated that the blood becomes more concentrated following the operation.

EXPERIMENTAL

In Chart 1 the upper part is presented to show the marked decrease in plasma volume which follows the operation while the lower part of the chart records the drop in serum volume.

Chart 2 is a record of the fibrin changes observed in 7 of the dogs following operation. In all cases studied, a rise in the percentage of fibrin was noted.

These observations suggested to us the possibility that our animals died because of anhydremia. Therefore we have tried to keep them alive by the administration of fluids in various media and by different channels of administration.

Effect of administering water by mouth. We have observed that the animals drank little, if any water following operation. Therefore, in our first attempt to maintain fluid balance we encouraged the animal to drink water and in addition we forced water through the stomach tube. The following animal illustrates the results of forcing fluids by mouth.

Dog 1 Male, weight 12.4 kilograms. Ether anesthesia operation November 8 9:20 p.m. Thirty-eight grams of liver were removed and dropped into the abdomen. Dog voided 100 cubic centimeters during the night.

9:20 a.m. Drank 100 cubic centimeters water
9:25 a.m. Vomited water and undigested meat.
9:30 a.m. 350 cubic centimeters water through stomach tube.

9:35 a.m. Vomited 350 cubic centimeters water
10:00 a.m. 350 cubic centimeters water through stomach tube vomited immediately 350 cubic centimeters water

10:45 a.m. 75 cubic centimeters water through stomach tube retained.

11:45 a.m. 100 cubic centimeters water through stomach tube, retained

1:45 p.m. Died (16 hours and 45 minutes after operation)

Postmortem revealed 175 cubic centimeters fluid in belly also fluid in stomach.

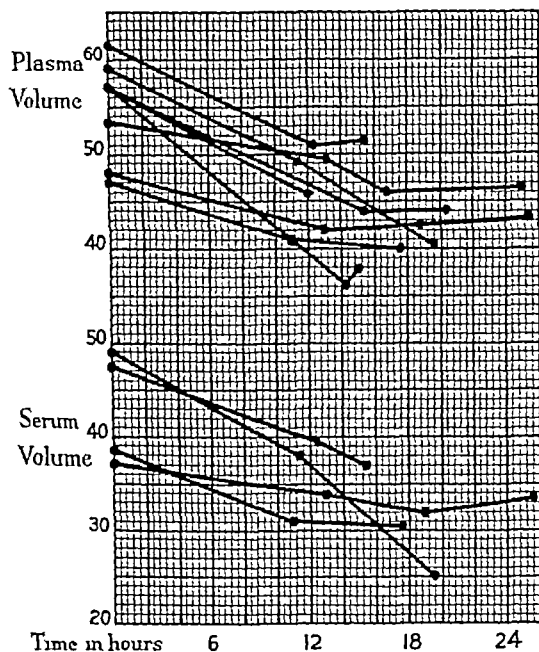


Chart 1 Decrease in plasma volume.

It will be noted that the animal lived only 16 hours and 45 minutes and at the time of death had 175 cubic centimeters of fluid free in the abdomen

Effect of drainage Assuming that the autolysis of the free liver tissue liberated a toxic substance which killed the animals, we next tried free drainage by inserting drains at the time of the operation. The following animal illustrates the value of drainage

Dog 2 Male, weight 13.2 kilograms. Ether anesthesia, operation November 16, 9:00 p.m. Fifty-seven grams of liver were removed and dropped into abdomen, 1 cigarette drain and 1 perforated drain were inserted. Dog voided 100 cubic centimeters of urine during the night. 9:45 a.m., died (12 hours and 45 minutes after operation) of respiratory failure, heart action strong and heart continued to beat for some time after death. No postmortem, dressing saturated.

It will be noted that the animal died in 12 hours and 45 minutes, which is one of the earliest deaths we have recorded.

Effect of administering glucose solution intravenously Forcing fluids by mouth did not prove entirely satisfactory due to the fact that the animals vomited much of the fluid administered. Therefore, we next tried fluids

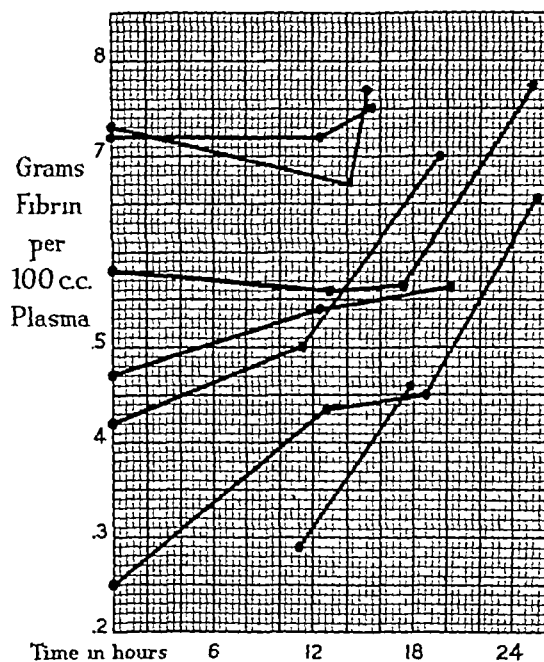


Chart 2 Fibrin changes

intravenously in the form of 6 per cent glucose. We used the Swan Meyer preparation for injection. Dog 3 illustrates the results.

Dog 3 Male, weight 15.9 kilograms. Ether anesthesia operation November 18, 8:00 p.m., 45.5 grams liver were removed and dropped into the abdominal cavity, 110 cubic centimeters 6 per cent glucose were given intravenously while animal was on table. He voided 250 cubic centimeters during the night.

8:30 a.m. 200 cubic centimeters 6 per cent glucose intravenously.

10:30 a.m. 190 cubic centimeters 6 per cent glucose intravenously.

10:30 a.m. Semi-liquid bowel movement tinged with blood.

11:00 a.m. Voided 100 cubic centimeters.

12:30 p.m. Died (16 hours and 30 minutes after operation). Total fluid given 500 cubic centimeters. Total fluid lost 350 cubic centimeters.

Postmortem 375 cubic centimeters very bloody fluid containing droplets of fat recovered from the abdominal cavity, omentum and peritoneum heavily injected with blood, as was mucous lining of stomach, also bloody fluid in stomach, free piece of liver and liver stump autolyzed, creamy in color, spongy, and emitted gas on pressure.

It is interesting that this animal received 500 cubic centimeters intravenously and

excreted 350 cubic centimeters also the amount of free fluid found at autopsy in the abdomen was 375 cubic centimeters which is more than noted in animals which had received less fluid.

Dog 4 is offered as a check and the results are essentially the same as for Dog 3

Dog 4. Male, weight, 15.5 kilograms, was operated upon November 24, at 8:00 p.m.—65 grams of liver were removed and dropped into the abdominal cavity 140 cubic centimeters 6 per cent glucose intravenously was given while on the table. Pan emptied in morning, 800 cubic centimeters bloody fluid, high specific gravity

8:15 a.m. 125 cubic centimeters 6 per cent glucose intravenously

8:30 a.m. Drank 75 cubic centimeters water Restless and whining, evidently in pain.

9:00 a.m. Resting quietly

9:15 a.m. Drank 80 cubic centimeters water

9:50 a.m. Drank 60 cubic centimeters water

10:30 a.m. Drank 60 cubic centimeters water

10:35 a.m. Vomited 60 cubic centimeters.

11:00 a.m. 240 cubic centimeters 6 per cent glucose intravenously Pan emptied, 310 cubic centimeters less color than in morning

1:00 p.m. Pan emptied, 150 cubic centimeters.

1:10 p.m. Died (13 hours and 10 minutes after operation) Total fluid intake 780 cubic centimeters fluid loss 780 cubic centimeters. No autopsy

Effect of gum acacia administered intravenously Our postmortem examinations led us to believe that the excess fluid appearing in the abdomen was due to a marked increase in the permeability of the abdominal viscera. We next tried gum acacia solutions in an attempt to hold the fluid in the circulation.

Dog 5. Female, weight 11 kilograms. On December 8 8:10 p.m. under ether anesthesia, 61 grams of liver were removed and dropped into the abdominal cavity under the spleen.

8:30 p.m. 103 cubic centimeters gum acacia were given intravenously

8:30 a.m. 160 cubic centimeters gum acacia were given intravenously

8:30 a.m. Voided 30 cubic centimeters clear straw colored urine, normal odor

10:45 a.m. Liquid stool. Out of cage, walking around laboratory Drank 100 cubic centimeters water and vomited immediately Vomitus clear and contained clear thick mucus.

11:50 a.m. 90 cubic centimeters gum acacia were given intravenously

1:00 p.m. Pan emptied, 40 cubic centimeters thick dark fluid. Condition seems good.

PHILLY'S gum acacia was used in 4 per cent solution, diluted with sterile physiological salt solution.

2:30 p.m. Drank 60 cubic centimeters water.

3:30 p.m. Condition seems good.

3:45 p.m. Animal in much worse condition. Two cubic centimeters adrenalin were given subcutaneously with no improvement, 1 cubic centimeter adrenalin was injected directly into the heart. Respiratory failure, artificial respiration with bellows.

1 cubic centimeter adrenalin in heart. Temporary recovery

4:10 p.m. Died (19 hours and 25 minutes after operation) Total fluid intake 513 cubic centimeters. Total liquid output 170 cubic centimeters.

Postmortem 375 cubic centimeters dark red fluid recovered from the belly cavity free piece of liver autolyzed and contained gas, peritoneum and omentum congested and hemorrhagic viscera, pale

Again it is noted that the animal received more fluid than excreted and, also that the abdomen contained a greater amount of free fluid.

DEDUCTIONS

In reviewing our experiments on this subject, we are impressed by two facts first, the blood studies show a decrease in plasma volume and, second, postmortem examination always reveals free fluid in the peritoneal cavity. We freely admit the presence of a gram-positive anaerobic bacillus however we do not believe it causes the death of the animals by producing a septic peritonitis. In our original paper we stated that there was no indication of a septic peritonitis and such peritonitis as is present should be considered as chemical.

We now are of the opinion that the sectioned liver undergoes autolysis and during the process a substance is liberated which causes a chemical peritonitis the condition then becomes one of increased permeability with the passage of fluid and bacteria into the peritoneal cavity. This interpretation agrees with the findings of Andrews and Hrdina who found that the reaction could be provoked by the implantation of sterile material.

The fluid lost into the abdomen is doubtless sufficient to cause circulatory disturbance however we have not been able to prolong life by administering fluids intravenously. We believe that the failure to prolong life by such means is attributable to the enormous increase in permeability of the abdominal viscera.

PHILLY'S gum acacia was used in 4 per cent solution, diluted with sterile physiological salt solution.

11:00 a.m. 240 cubic centimeters 6 per cent glucose intravenously Pan emptied, 310 cubic centimeters less color than in morning

1:00 p.m. Pan emptied, 150 cubic centimeters.

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CONCLUSIONS

1 Liver tissue undergoing autolysis within the peritoneal cavity liberates a substance which causes a chemical peritonitis which is accompanied by a marked increase in permeability of the abdominal viscera

2 Free fluid is always present in the peritoneal cavity of dogs dying from autolysis of liver tissue. The amount of free fluid usually being equal to one-third to one-half of the total blood volume

3 Accompanying the migration of free fluid into the peritoneal cavity there occurs a marked blood concentration

4 The institution of abdominal drainage, following operation, has shortened rather than prolonged the lives of the animals studied

5 Forcing fluids by mouth and intravenously did not materially lengthen the lives of any animals studied

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8:15 a.m. 125 cubic centimeters 6 per cent glucose intravenously

8:30 a.m. Drank 95 cubic centimeters water Restless and whining, evidently in pain.

9:00 a.m. Resting quietly

9:25 a.m. Drank 80 cubic centimeters water

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10:35 a.m. Vomited 60 cubic centimeters.

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1:00 p.m. Pan emptied, 150 cubic centimeters.

1:10 p.m. Died (13 hours and 10 minutes after operation) Total fluid intake 780 cubic centimeters fluid loss 750 cubic centimeters. No autopsy

Effect of gum acacia administered intravenously Our postmortem examinations led us to believe that the excess fluid appearing in the abdomen was due to a marked increase in the permeability of the abdominal viscera. We next tried gum acacia solutions in an attempt to hold the fluid in the circulation.

Dog 5 Female, weight 11 kilograms. On December 8 8:30 p.m., under ether anesthesia, 65 grams of liver were removed and dropped into the abdominal cavity under the spleen.

8:30 p.m. 105 cubic centimeters gum acacia were given intravenously

8:30 a.m. 160 cubic centimeters gum acacia were given intravenously

8:30 a.m. Voided 30 cubic centimeters clear straw colored urine; normal odor

10:45 a.m. Liquid stool. Out of cage, walking around laboratory Drank 90 cubic centimeters water and vomited immediately Vomitus clear and contained clear thick mucus.

11:30 a.m. 90 cubic centimeters gum acacia were given intravenously

1:00 p.m. Pan emptied, 40 cubic centimeters thick dark fluid. Condition seems good.

8:30 p.m. Drank 60 cubic centimeters water.

3:30 p.m. Condition seems good.

3:45 p.m. Animal in much worse condition. Two cubic centimeters adrenalin were given subcutaneously with no improvement 1 cubic centimeter adrenalin was injected directly into the heart. Respiratory failure, artificial respiration with bellows.

1 cubic centimeter adrenalin in heart. Temporary recovery

4:10 p.m. Died (19 hours and 15 minutes after operation) Total liquid intake 515 cubic centimeters. Total liquid output 170 cubic centimeters.

Postmortem 375 cubic centimeters dark red fluid recovered from the belly cavity: free pieces of liver autolyzed and contained gas, peritoneum and omentum congested and hemorrhagic; viscera, pale.

Again it is noted that the animal received more fluid than excreted and, also, that the abdomen contained a greater amount of free fluid.

DISCUSSION

In reviewing our experiments on this subject, we are impressed by two facts first, the blood studies show a decrease in plasma volume and, second, postmortem examination always reveals free fluid in the peritoneal cavity We freely admit the presence of a gram-positive anaerobic bacillus however we do not believe it causes the death of the animals by producing a septic peritonitis. In our original paper we stated that there was no indication of a septic peritonitis and such peritonitis as is present should be considered as chemical.

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The fluid lost into the abdomen is doubtless sufficient to cause circulatory disturbances however we have not been able to prolong life by administering fluids intravenously We believe that the failure to prolong life by such means is attributable to the enormous increase in permeability of the abdominal viscera.

22 Lilly's gum acacia was used in 8 per cent solution, diluted with sterile physiological salt solution.

TABLE I.—PATIENTS DISCHARGED HOME ALIVE

Summary of circumstances surrounding birth and treatment of 30 infants who failed to breathe promptly and were given prolonged artificial respiration in Drinker respirator, and who were discharged home alive.

Serial No.	Hospital number	Delivery	Birth weight		Breathing attempts before treatment	Treatment started minutes after birth	First spontaneous breath minutes of treatment	Frequent rhythmic breathing minutes of treatment	Duration of treatment in minutes	Duration of observation days	Condition on last observation
			lb	oz							
1	756SL	Spontaneous vertex	6	8	Fair	10	?	4	4	13	Alive
2	7800L	Spontaneous vertex	5	12	Poor	2	3	10	10	11	Alive
3	8258U	Spontaneous vertex	4	12	1	5	15	20	25	15	Alive
4	4689L	Low forceps	6	9	Gasps	5	?	8	8	12	Alive
5	7440L	Low forceps	7	3	Fair	7	2	10	10	10	Alive
6	4424L	Low forceps	6	13	Poor	11	1	10	10	12	Alive
7	7572L	Low forceps	8	4	Few gasps	8	5	7	7	13	Alive
8	5350L	Low forceps	8	4	2 gasps	8	1	7	7	23	Alive
9	8384L	Low forceps	5	2	Gasps	4	1	6	6	11	Alive
10	779 U	Low forceps	8	0	None	8	13½	5	8	13	Alive
11	7372L	Low forceps	6	15	Poor	5	2	5	10	22	Alive
12	8599L	Low forceps	5	13½	Poor	1	3	7	7	12	Alive
13	8411L	Low forceps	7	0	Gasps	9	1	5	5	12	Alive
14	8454L	Low forceps	7	0	Poor	2	?	13	14	11	Alive
15	8446L	Low forceps	7	9	Poor	2	1	10	10	12	Alive
16	3377L	Mid forceps	6	0	Gasps	9	?	15	15	10	Alive
17	8252L	Mid forceps	7	15	1 gasp	5	?	11	11	14	Alive
18	7236L	High forceps	7	14	None	10	1	15	15	10	Alive
19	8055U	High forceps	5	0	Few gasps	10	2	5	5	12	Alive
20	7055U	High forceps	7	0	?	10	5	15	15	17	Alive
21	7901U	High forceps	8	8	2 gasps	5	?	2	5	21	Alive
22	8355L	Spontaneous breech	5	4	Gasps	7	3	25	25	19	Alive
23	2460L	Version	5	3	1 gasp	1	1	20	27	29	Alive
24	7055L	Version, A.C.H.F.*	7	6	Gasps	9	?	5	5	14	Alive
25	5184L	Version, A.C.H.F.*	6	0	Gasps	5	2	24	24	11	Alive
26	7571L	Version A.C.H.F.*	5	13	Poor	3	2	10	10	18	Alive
27	7807L	Version A.C.H.F.*	6	6	Poor	8	2	?	6	13	Alive
28	7705L	Cesarean	6	0	Poor	8	?	15	15	19	Alive
29	8301L	Cesarean	6	13	Gasps	5	2	15	15	15	Alive
30	8161U	Cesarean	4	9	None	5	4	7	7	17	Alive

*A.C.H.F., after coming head, forceps

such had occurred before the treatment was started, whereas just prior to the beginning of treatment no appreciable change had taken place

In the presence of extremely inadequate spontaneous breathing and apnea, the treatment had a decidedly beneficial influence upon the duration of heart action. Information was secured concerning the cardiac action of 8 infants, some of whom never

breathed spontaneously, and some who gave only an occasional gasp. In none did a normal type of breathing ever develop, and all died while under treatment. The heart of one infant which never gasped, was beating 23 minutes after the start of treatment. Another infant, which gasped before the start of treatment, but never thereafter, exhibited heart action 21 minutes later. A third, which also never gasped after the start

ASPHYXIA NEONATORUM

ITS CAUSES AND TREATMENT BY PROLONGED ARTIFICIAL RESPIRATION. REPORT OF SIXTY SIX CASES

DOUGLAS P. MURPHY, M.D., F.A.C.S., PHILADELPHIA, PENNSYLVANIA, AND J. VALTON SESSUM, M.D., GALVESTON, TEXAS

From the Gynecoma Hospital, Institute of Gynecologic Research, and Hospital of the University of Pennsylvania and the Philadelphia Lying In Hospital.

THE present report concerns 66 infants who failed to breathe promptly at birth and were given prolonged artificial respiration. Record was made of their breathing activity both before and after the start of treatment, and in those cases in which death occurred necropsy was performed when possible. The circumstances surrounding each case were studied to determine the cause of the respiratory difficulty and the response of the patient to treatment.

The observations were made in the Hospital of the University of Pennsylvania and in the Philadelphia Lying In Hospital where the 66 treated infants represented 3.6 per cent of all live births.¹

The indications for treatment were absence of any breathing activity (as a result of which a number of stillborn infants were unintentionally treated) or very feeble and infrequent breathing attempts.

The treatments were given by means of a Drinker respirator (Fig. 1); the construction and mode of action of which are evident from the following brief description.

The patient is placed in a metal box or respirator with his head protruding from one end through a snugly fitting rubber collar. When the respirator is closed the body is in a relatively air tight container with the head exposed to room air. By means of an electrically driven air pump and valve arrangement changes of air pressure are induced within the respirator. Thus, moderate degrees of accurately measured negative pressure are made to alternate rhythmically with atmospheric pressure. When negative pressure is applied, air at atmospheric pressure enters the respirator through the nose, mouth, and trachea; it enters the lungs and the chest expands. When the negative pres-

sure within the respirator returns to normal, the elastic recoil of the chest produces expiration.

All treatments were started within 30 minutes of birth and in most cases within 5 minutes or less. Variation in the length of this time interval had no appreciable influence upon the mortality rate.

After the respirator was started, the infant's respiration was watched closely. The respiratory movements could be observed by watching the infant's head outside of the respirator tank, or the chest movements through the celluloid windows of the machine. Two chief types of breathing were observed. The first breathing attempts, as a rule, were spasmodic, infrequent, and feeble, and for the sake of conciseness may be described as *inadequate breathing*. If normal or *adequate* breathing developed, the earlier breathing gradually changed and became more frequent and less spasmodic. Treatment was maintained until the earlier type of breathing changed to normal or until death took place. Death was determined by cardiac auscultation, after stopping the motor and opening the respirator.

Respiratory power. The respiratory power of the 66 infants (Tables I and II) may be summarized as follows. Fifteen infants failed to breathe at any time, though the hearts of 3 were known to be beating after birth. Five breathed before, but never after the start of treatment. Of the remaining 46 which breathed at least once during treatment, 39 developed finally an adequate degree of respiratory activity. Of these, 30 survived and 9 died in the hospital.

The influence of artificial respiration. The first visible effect of the operation of the respirator in many cases, was a decided change in the frequency and vigor of the spontaneous respiratory movements, when

¹The authors are indebted to Drs. Edmund B. Peiper and Morris W. Levy and their associates for the privilege of reporting the present case studies.

TABLE III—TIME OF ONSET OF NORMAL RHYTHMIC BREATHING

Showing the number of infants who did not breathe promptly at birth, and were given prolonged artificial respiration, arranged to indicate the amount of treatment required before normally rhythmic breathing began. Note that death in hospital followed when normal breathing failed to begin within 25 minutes of treatment, and that 1 patient required 75 minutes of treatment before normal breathing developed.

Minutes of treatment	Lived to	
	go home	died in hospital
1 to 5	7	4
6 to 10	11	0
11 to 15	7	0
16 to 20	2	0
21 to 25	2	1
26 to 30	0	0
31 to 35	0	0
36 to 40	0	1
41 to 45	0	1
46 to 50	0	0
51 to 55	0	1
After 74 minutes	0	1
	29	9

of treatment, showed heart action 50 minutes after the onset of the treatment. How long the hearts of these infants continued to beat following their last examination cannot be stated, since the respirator was not opened again in each case, until death had taken place. The necessity of stopping the treatment in order to auscult the heart, accounted for the small number of observations made upon this aspect of the patient's response to treatment.

Time of onset of rhythmic normally frequent breathing. The time of onset of normal breathing of 38 infants is recorded in Table III. From a study of this table it is evident that ultimate survival did not occur if more than 25 minutes of treatment were required, though 4 infants which needed longer treatment, lived for some hours or days. Another point of interest is that normal breathing of 1 of 3 infants did not develop until 1 hour and 15 minutes of treatment had been received. The 2 other infants did not breathe normally for periods of 43 and 54 minutes, respectively. The first and last died of prematurity, the second of cerebral hæmorrhage.

Infants which breathed adequately and died. Information is given in Table IV regarding 11 infants which finally breathed adequately in the respirator, and then died before leaving the hospital. Of the 11 infants, 10 were pre-

TABLE IV—INFANTS DEVELOPING ADEQUATE RESPIRATORY ACTIVITY BUT DYING IN THE HOSPITAL

Showing the number of infants who developed an adequate respiratory activity while receiving artificial respiration but who died in the hospital. Note the low birth weights in this series, and the fact that 3 lived for 24 hours or longer.

Number	Weight		Duration of life			Cause of death
	lbs	oz.	days	hours	mins	
1	3	4½		5	50	C. H.*
2	5	1½		10	40	C. H.*
3	3	3½	1			Premature
4	3	2		5	38	Premature
5	2	7½		4	20	Premature
6	2	3		14	05	Premature
7	2	15½	17			Premature
8	2	11		16	50	Premature
9	4	3½	5			Premature
10	4	7½		6	54	Premature
11	5	10½		8	25	Toxæmia (maternal)

* C. H., Cerebral hæmorrhage.

mature and weighed less than 5½ pounds. All lived 4 hours, and 3 lived more than 24 hours. Death in 8 cases was the result of prematurity.

Causes of respiratory difficulty. Of the 66 treated infants, 30 were finally discharged home alive (Table I) and the remaining 36 were either stillborn or died in the hospital (Table II). The reasons for the respiratory difficulty in these 66 infants, which require certain explanations, are recorded in Table V.

The causes of the difficulties of the *surviving* infants are based upon *clinical* examination *alone*, whereas those of the stillborn and dead infants are based also in part on necropsy findings. If 2 or more causes operated, only the most likely one is given in Table V.

From a glance at this table it will be seen that the majority of the 66 infants suffered from narcosis, or from injury due to delivery, from both breech delivery and forceps operations. These three factors were responsible for 42, or 63.6 per cent, of the respiratory disturbances.

TABLE II.—STILLBIRTHS AND DEATHS IN HOSPITAL

Summary of circumstances surrounding birth and treatment of 36 infants who failed to breathe promptly at birth and were given prolonged artificial respiration in Drinker respirator and who were either stillborn or died in hospital.

Serial No.	Pregnancy	Delivery	Birth weight		Breathing at attempt before treatment	Treated (artificial respiration) after birth	First convulsions (localizing) after birth	Present (clonic) convulsions after treatment	Duration of treatment in minutes	Duration of observation			Cause of death	Method of diagnosis
			lb.	oz.						Days	Hours	Minutes		
1	8634L	Verma, A.C.H.F.	4	12	None	8	None	None	118	1	10	40	Dead/Cerebral hemorrhage with bacterial infection	Microscopy
2	7021L	Branch	4	10	3 gasps		3	None	48		48	48	Dead/Cerebral hemorrhage with bacterial infection	Microscopy
3	8077L	Verma, A.C.H.F.	11	3	Four	5	None	None	30		17	17	Dead/Cerebral hemorrhage with bacterial infection	Microscopy
4	8071L	Verma	8	10	gasp		7	None	37		37	37	Dead/Cerebral hemorrhage with bacterial infection	Microscopy
5	8108U	Branch, A.C.H.F.	3	14	None		None	None	41		41	41	Dead/Cerebral hemorrhage with bacterial infection	Microscopy
6	7047L	Branch	6	8	None		None	None	48		48	48	Dead/Cerebral hemorrhage	Microscopy
7	4797L	Verma, A.C.H.F.	9		None	4	None	None	13	2	5	5	Dead/Cerebral hemorrhage	Microscopy
8	7046L	Black forceps	3	7	3 gasps	3	None	None	9		9	9	Dead/Cerebral hemorrhage	Microscopy
9	8197L	Spontaneous vertex	7		gasp	3	None	None	47		47	47	Dead/Cerebral hemorrhage	Microscopy
10	7734L	Low forceps	3	4 1/2	(Normal)		3	43	47	1	30	30	Dead/Cerebral hemorrhage	Microscopy
11	8131L	Spontaneous vertex			Four gasps	5	10	None	30	1	30	30	Dead/Cerebral hemorrhage	Microscopy
12	8017U	Low forceps	6		None	5	None	None	7		7	7	Dead/Cerebral hemorrhage	Microscopy
13	8019U	Mid forceps	5	6	None	3	None	None	30		30	30	Dead/Cerebral hemorrhage	Microscopy
14	6977U	Low forceps	6	3	None		None	None	64		64	64	Dead/Cerebral hemorrhage	Microscopy
15	8073L	Verma, A.C.H.F.	8	3	None		41	None	161	0	17	17	Dead/Cerebral hemorrhage	Clinical
16	8073U	Low forceps	7	4 1/2	None		None	None	30		30	30	Dead/Cerebral hemorrhage	Clinical
17	7317U	Branch, A.C.H.F.	7	13	None	4	None	None	30		30	30	Dead/Cerebral hemorrhage	Clinical
18	8774L	Verma, A.C.H.F.	7		None		None	None	4		4	4	Dead/Cerebral hemorrhage	Clinical
19	6664L	Verma, A.C.H.F.	5	10	Four	10		3	30	20	40	40	Dead/Cerebral hemorrhage	Clinical
20	7034L	Branch	3	10	Four	7	10	3	3		3	3	Dead/Prematurity	Microscopy
21	7043L	Verma, A.C.H.F.	3		None	3	3	30	30	1	40	40	Dead/Prematurity	Microscopy
22	6134L	Verma		7 1/2	cries	3		43	61	4	30	30	Dead/Prematurity	Microscopy
23	7371L	Verma	3		gasp			34	35	14	5	5	Dead/Prematurity	Microscopy
24	7131L	Spontaneous vertex	1 1/2		Gasp	3	7	3	15	17	6	6	Dead/Prematurity	Clinical
25	7041L	Branch			Four	10	7	7	30	10	30	30	Dead/Prematurity	Clinical
26	7461L	Low forceps	4	3 1/2	None			75	40	5	4	4	Dead/Prematurity	Clinical
27	7106L	Branch	4	7 1/2	Four	5	3	4	3	4	50	50	Dead/Prematurity plus later pneumonia	Microscopy
28	7047L	Low forceps	9		None	3	None	None	13		13	13	Dead/Prolonged labor	Microscopy
29	7043L	High forceps	7	13	Four		7	None	70		70	70	Dead/Prolonged labor	Clinical
30	8019U	Mid forceps	6	3	None		None	None	45		45	45	Dead/Prolonged cord	Microscopy
31	7045L	Spontaneous vertex	7	8	Four		None	None	63		63	63	Dead/Prolonged cord	Microscopy
32	7266L	Branch, A.C.H.F.	6	7	None	3	None	None	11		11	11	Dead/Prolonged cord	Clinical
33	7321L	Branch, A.C.H.F.	6		None		None	None	3		3	3	Dead/Stillbirth	Microscopy
34	7071U	Low forceps	5	11	None		None	None	36		36	36	Dead/Stillbirth	Microscopy
35	7041L	Spontaneous vertex	3	10 1/2	Four		7	7		8	15	15	Dead/Maternal toxemia	Clinical
36	7702L	Spontaneous vertex	3	14	Four		14	None	3		3	3	Dead/Asphyxia—cord tight around neck	Clinical

A.C.H.F. after coming head, forceps.
Two infants.

TABLE VII—MODE OF DELIVERY

Showing the mode of delivery of 66 infants who failed to breathe promptly at birth and were given prolonged artificial respiration, and the number of infants discharged home with their mothers. Note the small number discharged home alive following breech delivery.

Delivery	Number of infants	Number discharged alive	Per cent discharged alive
Forceps (all)	29 (100%)	18	62
Breech (including versions)	25 (100%)	6	24
Spontaneous vertex	9 (100%)	3	33
Cæsarean operation	3 (100%)	3	100
Totals	66 (100%)	30	45.5

TABLE VIII—BREATHING ACTIVITY BEFORE START OF TREATMENT

Showing the nature of the breathing efforts before start of artificial respiration of 66 infants who failed to breathe promptly at birth, and the number of them discharged home alive. Note the small number surviving, of those who failed to breathe at all before the start of treatment.

Nature of breathing before entering respirator	Number of infants	Infants discharged home alive	Number	Per cent
Gasps	22	15	67	
None	21	3	14.3	
Poor	17	9	53	
Fair	3	2	66	
Not stated	1	1		
Normal for only few minutes	1	0		
Two cries	1	0		

15, or 67 per cent, survived. In the group in which the breathing was recorded as *poor* (17 cases), the salvage was not as good (53 per cent) as where it was gasping in character (salvage 67 per cent).

Analysis of deaths. Thirty-six infants died (Table II) and necropsies were performed upon 24 (Table IX). Fifteen of the 36 were stillborn. The causes of the stillbirths were as follows: cerebral hæmorrhage, 10, prolapsed cord, 2, unknown, 2, prolonged labor, 1.

Cerebral injury accounted for 19 (52.6 per cent) of the 10 stillbirths and 9 deaths, being confirmed in 10 cases by necropsy. Of the 9 infants with cerebral injury which breathed, only 2 developed an adequate degree of breathing, 1 living 5 hours, and another, 10 hours.

In 5 (one-third) of the cerebral injury cases, which came to necropsy, tentorial tear was observed. The delivery in each case was by the breech.

TABLE IX—CAUSES OF DEATH

Showing the causes of death, based on both clinical and necropsy material, of 36 infants who failed to breathe promptly at birth and were subjected to artificial respiration. The pathological diagnosis is recorded wherever possible. Note the high incidence of cerebral hæmorrhage.

Cause of death	Number of infants	Number of necropses
Cerebral hæmorrhage	19	14
Prematurity alone	7	4
Prematurity with lobar pneumonia	1	1
Prolapsed cord	3	2
Prolonged labor	2	1
Stillbirth	2	2
Maternal toxæmia	1	0
Asphyxia (cord about neck)	1	0

OBSERVATIONS MADE FROM STUDY

From this study certain observations regarding the cause of immediate respiratory failure at birth, and the response of the patients to treatment, stand out.

Narcosis appears to be the most common single cause of respiratory difficulty, though when the various forms of operative delivery are grouped together they far outweigh it. The importance of the maternal narcosis, especially if operative delivery is to be employed, therefore should not be underestimated, and if possible such maternal treatment should be reserved for the earlier part of labor, being given not later than 4 to 5 hours prior to the expected time of delivery. Otherwise, the influence of the narcotic upon the infant, especially if operative delivery is required, may be just sufficient to throw the balance to the wrong side, even though every effort is made to conserve the infant's life.

The influence of operative delivery upon the infant's respiratory activity, whether the delivery is by the breech or by forceps, is quite evident, and the high mortality following breech delivery as compared with forceps delivery is also apparent, especially as this form of delivery appears to be followed by the most severe type of intracranial injury.

Prolonged artificial respiration, by the use of the Drinker machine, has distinctly a beneficial effect upon respiration, and in all probability a life saving one, though an exact measure of this part of its value is necessarily impossible in view of the varied

TABLE V.—CLINICAL REASONS FOR RESPIRATORY DIFFICULTY

Showing the clinical causes for respiratory difficulty of 66 infants who failed to breathe promptly at birth. Note the large numbers suffering from narcosis and operative delivery

Cause	Number of infants
Narcosis	6
Breech delivery	14
Forceps delivery	2
Prematurity	8
Cord difficulties	6
Unknown	4
Prolonged labor	3
Enlarged thymus gland	
Premature separation of placenta	1
Maternal toxemia	1
Total	66

In the case of the 30 infants which went home alive (Table I) 3 suffered from injury during version and breech extraction, 6 from injury during forceps delivery. Five infants suffered from enlarged thymus (1) premature separation of the placenta (1) prolonged labor (1) and cord about the neck (2). The remaining 16 infants (Tables V and VI) suffered an asphyxia due to the use of narcotics at least no other cause could be found. Since the dosages were not excessive, it is believed that the short time intervals between treatment and birth account for the infant's respiratory difficulties.

Of the 36 infants which did not survive (Table II) 19 suffered cerebral injury most of these patients (14) came to necropsy. Since the injuries occurred during delivery these deaths are attributed to the operative interference and are so classified in Table V. With these explanations the clinical diagnoses in Table V will be understood.

Mode of delivery. The majority (57 or 86.5 per cent) of the 66 deliveries required operative interference (Table VII) breech presentations being included in this group. There were only 9 spontaneous vertex deliveries in the entire series. The mortality of the infants delivered by the breech was twice that of those delivered by forceps.

Relation of prematurity to survival. Of 21 infants which weighed less than 5½ pounds, 7 (33.3 per cent) were discharged home alive, whereas of the remaining 45 which weighed over 5½ pounds, 51.1 per cent survived.

TABLE VI.—SURVIVING INFANTS IN WHOM THE ASPHYXIA CAN BE ATTRIBUTED TO NARCOSIS.

Showing the amount of narcotic and the interval between administration and birth, for 16 infants who failed to breathe promptly at birth, and were given artificial respiration. No other cause for respiratory difficulty could be determined. All 16 infants survived.

Serial No.	Dose of drug	Length of time given before delivery
	Morphine sulphate gr ¼ Magnesium sulphate (90%) 3 c.c.m.	3 hr. 25 min.
	Morphine sulphate gr ¼ Scopolamine gr 1/100	4 hr. 30 min.
3	Sodium amytal	3 hr. 45 min.
4	Morphine sulphate gr ¼ Magnesium sulphate (90%) 3 c.c.m.	1 hr. 15 min.
5	Morphine sulphate gr 1/6	hr.
6	Morphine sulphate gr 1/6 Scopolamine gr 1/100	1 hr. 30 min.
7	Morphine sulphate gr 1/6 Scopolamine gr 1/100	hr. 30 min.
8	Morphine sulphate gr 1/6	hr. 25 min.
9	Morphine sulphate gr ¼ Scopolamine gr 1/100	hr. 30 min.
	Morphine sulphate gr 1/6	hr. 30 min.
11	Sodium amytal gr vi Morphine sulphate gr 1/6 Scopolamine gr 1/100	2 hr. 8 min.
12	Morphine sulphate gr ¼ Scopolamine gr 1/100	3 hr. 50 min.
13	Morphine sulphate gr ¼ Scopolamine gr 1/100	3 hr. 50 min.
14	Morphine sulphate gr ¼ Scopolamine gr 1/100	hr. 32 min.
15	Morphine sulphate gr 1/6	30 min.
16	Morphine sulphate gr ¼	hr. 30 min.

Relation of pre-treatment respiratory activity to survival. The nature of the respiratory activity before birth is recorded in Table VIII. In 21 instances no breaths were observed. Of these infants, 15 never breathed, even after the start of treatment whereas 6 did so during that period. Three of the 6 survived.

Gaspings respiration was noted in one-third (22 cases) of the infants, and of this number

already witnessed) and a life be saved which otherwise might be lost

SUMMARY

1 The causes of respiratory difficulty of 66 infants which failed to breathe promptly at birth are recorded and also their responses to prolonged artificial respiration

2 Fifteen infants never breathed, 21 breathed before or during treatment, only to die in hospital, and 30 infants were discharged home alive

3 The commonest cause of respiratory difficulty was narcosis

4 Breech delivery was followed by the greatest number of deaths, and by the most extensive cerebral injuries

5 The Drinker respirator exhibited a stimulating effect upon respiratory activity, and made possible prolonged heart action

6 Patients who required artificial respiration for more than 20 minutes, were discharged home alive, patients who failed to breathe normally during the first 35 minutes of treatment, in fact, 1 patient during the first 75 minutes, lived for several days

7 The premature infants and those suffering from narcosis exhibited the best response to prolonged artificial respiration

8 Patients failing to take a single breath before the start of treatment exhibited a high mortality

9 The chief cause of death was cerebral hæmorrhage, prematurity being next most common

10 Suggestions are offered concerning the details of treatment by means of the Drinker respirator, and a modification in the running of the machine is recorded

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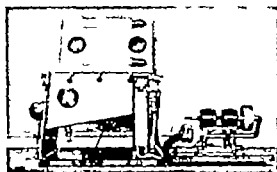


Fig. 2. Showing Drinker respirator side view and top open, for the prolonged artificial respiration of newborn infants. The rate and depth of artificially induced breathing, induced by the rheostat controlled motors, air pump, and valve shown on the right, are registered by the manometer seen in the center of the picture.

and serious conditions to be found in the patients treated. It appears to have a stimulating effect upon the respiratory activity of infants who are not extremely deeply asphyxiated, and apparently is capable of maintaining cardiac action for long periods in infants more deeply asphyxiated.

As far as can be learned, it has no injurious effect upon the infant and appears to be exceedingly gentle in its action. This latter fact is exemplified in the following experience in the University Clinic:

An infant weighing 1 pound and 11 ounces at birth, became cyanotic and stopped breathing $3\frac{1}{4}$ hours later. He was placed in the respirator and given artificial respiration continuously for 6 hours and 33 minutes during which time he gasped 356 times, or approximately one breath every 72 seconds. Death finally occurred.

In general it may be said that the respirator is of greatest value in the treatment of infants suffering from excessive narcosis and in aiding those which are premature, since the former show the lowest mortality and the latter also appear to survive their immediate asphyxia though they may not always live a long time after birth. There is no contra-indication, however, to employing the method in the treatment of every infant who fails to breathe promptly at birth, with the hope that by its aid some of them may survive this critical period.

Some of our earlier observations dealing with the treatment of asphyxia neonatorum by the use of the Drinker respirator lead to the conclusion that negative pressure, without the use of an alternating positive pressure but alternating with atmospheric pressure, is sufficient to bring about an adequate degree of pulmonary ventilation. During the present study in the presence of moderate degrees of asphyxia negative pressure alone was found to be quite efficient. However in certain cases of very severe asphyxia this was not the case. Accurate measurement of the air moving to and from the lungs of some deeply asphyxiated infants, with the respirator running, and experimentation with the use of an alternating positive pressure, indicated that, in these cases of severe asphyxia, the added use of positive pressure is advantageous instead of alternating the negative pressure solely with that of the atmosphere. As a result of these observations, it is believed advisable always to use both negative and positive pressure whether the asphyxia is mild, moderate, or severe in degree. It has been found advisable also from experiments upon asphyxiated cats never to allow the positive pressure to exceed that of the negative pressure, and preferably to use both at the same level. The changes in the machine necessary to the proper use of positive pressure with negative pressure, are very easily made directions for which can be secured from the manufacturer.

Concerning the proper duration of prolonged artificial respiration for asphyxiated infants, it is deemed advisable to continue treatment for at least an hour or until death takes place. Although ultimate survival is rather unlikely if normal breathing does not develop within the first 30 minutes, it cannot yet be stated that infants which fail to breathe normally for the first time after that period has elapsed will necessarily abortly die. If the infant is premature it is best to keep it in the respirator a matter of days, or until it is well past its last attack of respiratory weakness, cyanosis, or apnea. By so doing, if constant attendance is maintained subsequent attacks of a serious nature, may be promptly and adequately treated (as some of us have

TUBERCULOUS BACILLURIA

As operative therapy for tuberculosis of the kidney was more widely employed, it became imperative to develop more accurate and infallible methods for diagnosing the disease, especially in its early forms. In this diagnosis the demonstration in the urine of the causative organism, the tubercle bacillus, played an important rôle. Casper and Israel in the early years of this century, were of the opinion that the presence of the organism in the kidney urine indicated a tuberculous process in the kidney. On the basis of this assumption, numerous surgeons began to perform nephrectomy in cases in which the organism had been found in the kidney urine. As this procedure began to be used more widely, frequent reports appeared in the literature of cases in which the organism was found in the kidney urine and in which nephrectomy revealed a normal kidney or one which was the seat of merely non-specific inflammatory changes and not of a tuberculous process (Fedorow, Rhimer). This resulted in a renewed interest in the older studies on bacilluria, and especially tuberculous bacilluria.

From these studies it was assumed that the tubercle bacilli which were circulating in the blood stream could be excreted by the kidney. Some authors contended that the normal organ is permeable for the bacilli, while others believed that only a kidney previously damaged by chemical or mechanical trauma, or any of a variety of disease processes, would allow the tubercle bacilli to pass through it from the blood into the urine. It was also believed that the organisms could produce non-specific inflammatory changes in the kidney (tuberculous nephritis), which could serve as the source of tubercle bacilli which appeared in the urine. Such a kidney, it was believed, could either heal or could undergo shrinkage. It was thought that nephrectomy in such a case amounted to a needless sacrifice of a vital organ.

It was further assumed that the excretion of tubercle bacilli by the secretory apparatus of the kidney played an important rôle in the development and the further spread of the tuberculous process in the renal substance.

The organisms were said to be excreted by the glomeruli (Orth and Ernst Meyer) to appear in the tubules and thus to attack the renal parenchyma. Others were said to find their way with the urine to the straight tubules in the medulla where they either attacked the renal parenchyma or were carried further to the tips of the papillæ, where a specific lesion then developed. This sort of a process, in which the organisms are excreted by and then attack the tissues of an organ, is known as an *excretion tuberculosis* (*Ausscheidungstuberculose*).

But strangely enough a study of the experimental literature reveals that most investigators confined their efforts to an observation of the changes which the tubercle bacillus produces in the kidney and to a demonstration of the organisms in the renal tissue. Careful studies of the urine were usually not carried out. This was undoubtedly due to the unsatisfactory methods which then prevailed for demonstrating the tubercle bacillus in the urine.

Paul Courmont and Hugel demonstrated that if 2 milligrams of a culture of tubercle bacilli is injected intravenously in an animal, the organisms rapidly disappear from the blood stream (10 to 15 minutes) and can no longer be demonstrated by staining. In this time they seem to be filtered off by the various organs, mainly by the lung, to a lesser extent by the liver, and thirdly by the spleen. The studies of Lesieur and Gary brought similar results. Titze found that if small or moderate doses of bovine tubercle bacilli are injected intravenously in cattle and goats, the organisms disappear from the blood stream at the latest in 9 days. If fatal doses are injected, the organisms are still demonstrable throughout the entire life of the animal.

Courmont and Dor, Gilbert and Roger believed that the development of a local tuberculous process, such as a renal tuberculosis, rather than a generalized infection, depends upon the virulence rather than the number of the injected organisms.

Friedrich injected large numbers of weakly virulent tubercle bacilli into the left ventricle of rabbits. He observed mainly contractures of the kidney, which took their origin from the glomeruli. The injection of virulent organisms resulted in the development of a marked renal tuberculosis in addition to a pulmonary tuberculosis.

Pels Leusden believed that the contractures seen in Friedrich's experiments with weakly virulent organisms may be explained on a purely embolic basis. He attributed the renal involvement in the cases in which virulent organisms were used to the

TUBERCULOUS BACILLURIA AND EXCRETION TUBERCULOSIS

AN EXPERIMENTAL STUDY¹

FREDERICK LIEBERTHAL, B.A., M.D. CHICAGO, AND THEODORE VON HUTH, M.D. BUDAPEST, HUNGARY

IN cases of generalized infection the organisms have repeatedly been demonstrated in the various body secretions such as the urine and the feces, the bile, the mucus, the sweat, the milk, the saliva, in pleural and peritoneal effusions, in the spinal fluid, and in the semen. The question as to whether bacilli can be excreted by and pass through, the normal kidney has long been disputed. Originally this problem had merely a theoretical interest but with the development and the refinement of the various methods for diagnosing renal pathology in the living, with the purpose of instituting the proper therapy this question has assumed a very definite clinical importance. Since it was obviously the function of the kidney to excrete toxic metabolism products from the organism, and since pathological bacteria were frequently found in the urine of patients afflicted with infectious diseases, it was natural to assume that the elimination of pathogenic organisms by excretion through the kidney is an important defense mechanism of the body.

A careful consideration of the various experimental studies on non-tuberculous bacilluria reveals that all of those investigators who carried out careful histological studies of the kidneys in their experiments (Opitz, Koch, and Pernice and Scagliosi) found that pathological changes (blood vessel rupture epithelial degeneration, glomerulonephritis) developed before an "excretion of the organisms occurred. The fact that the number and the virulence of the bacteria injected also played an important part in their excretion (Sittmann Koch) also strengthens this observation.

Most investigators (Koch, Patet, Wyszokowitch, Ribbert, Pernice and Scagliosi Sittmann Streng) saw a late "excretion" (4 hours). The early appearance of the organisms in the urine observed by Biedl and Kraus, and v Kleckl (5 minutes) we may assume

(with Opitz and Koch) to be due to the unphysiological conditions under which the experiments were carried out. Further the placing of a cannula into the cut end of the ureter (Biedl and Kraus, v Kleckl) is very apt to lead to a contamination of the urine with blood, which will allow the organisms to find their way mechanically into the urine.

If a true physiological excretion occurred, we should expect the organisms to be excreted regularly by the kidney under the same conditions. But this obviously does not occur. Further one would expect to see an accumulation of the organisms in the renal tissues (as suggested by Opitz) as occurs in the excretion of other substances by the kidney. But the histological studies of Opitz and v Kleckl showed that only occasional organisms were found to be present in the renal tissues.

Under conditions of physiological excretion, one would also expect the bacteria to accumulate to such a degree in the urine that they would be present there in a much greater concentration than in the blood. This occurs in the excretion of other substances (urea, sugar etc.) But the quantitative studies of Biedl and Kraus, v Kleckl, and Opitz showed the appearance of only a few organisms in the urine in spite of the fact that many millions or even billions of them were circulating in the blood.

The experiments of Wyszokowitch, v Kleckl, and Koch showed that organisms which are injected into the blood stream rapidly disappear from the circulation. They tend to pass through the circulation of the kidneys to lodge in other organs, such as the liver the spleen, the lungs and the bone marrow—where they are subsequently destroyed by the activity of the cells of the tissues. *This and not excretion by the kidney is the main defense mechanism of the body in cases of generalized infection.*

¹From the Royal Hungarian Academy of Sciences, University of Budapest—(1) From the First Institute of Pathology, Budapest, Hungary; (2) From the Department of Pathology of the Microbiology Institute, Budapest, Hungary; (3) From the Department of Pathology of the Microbiology Institute, Budapest, Hungary; (4) From the Department of Pathology of the Microbiology Institute, Budapest, Hungary; (5) From the Department of Pathology of the Microbiology Institute, Budapest, Hungary; (6) From the Department of Pathology of the Microbiology Institute, Budapest, Hungary; (7) From the Department of Pathology of the Microbiology Institute, Budapest, Hungary; (8) From the Department of Pathology of the Microbiology Institute, Budapest, Hungary; (9) From the Department of Pathology of the Microbiology Institute, Budapest, Hungary; (10) From the Department of Pathology of the Microbiology Institute, Budapest, Hungary; (11) From the Department of Pathology of the Microbiology Institute, Budapest, Hungary; 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tubercle bacilli in 24 hour portions according to the method of Loewenstein-Sumyoshi on the egg medium of Hohn. Four tubes were inoculated from each portion, 1440 cultures were made in all. In this way we had no fear of contamination with organisms other than acid fast bacilli, for the former would be destroyed subsequently by the sulphuric acid used in the procedure. Direct smears of the urine were also made, and these were stained by the method of Ziehl-Neelsen or of Osol.

Cantharidin nephrosis, uranium nephritis, and mercurial nephrosis of varying degrees of severity were induced in some of the animals by injection of cantharidin in oil, bichloride of mercury, or uranium nitrate. After sufficient time had elapsed for lesions to develop, tubercle bacilli were injected intracardially and the urine was examined for the bacilli to determine if the lesions previously produced had made the kidneys permeable for the organisms.

At varying intervals after the injection, the animals were killed by a blow on the neck, and careful histological studies of the kidneys, and in some cases of the other organs, were carried out. The specimens were stained with the hematoxylin-eosin, Ziehl-Neelsen, and Van Gieson stains.

For the injections we prepared suspensions from cultures of tubercle bacilli of varying age, virulence, and type. These were carefully mixed with physiological salt solution by grinding in a mortar for several hours. This was done so as to avoid, as far as possible, the presence of larger masses of bacilli which might act as emboli and lodge in the renal vessels, causing pathological changes. The organisms were then counted according to the method of Zelter so as to obtain a rough idea as to the number injected in each case.

SUMMARY OF THE ANIMAL EXPERIMENTS

Among 8 cases in which the tubercle bacilli were injected into the ear vein, 5 developed specific lesions in the lungs only, 1 developed specific lesions in the lungs and in the kidney, and 2 developed no lesions. Culturing and smears of the total urine excreted for 20 days failed to show the presence of tubercle bacilli.

Among 6 cases in which the bacilli were injected intracardially specific renal lesions developed in 2 cases. In one of these tubercles were also present in the lungs, and in the second also in the liver and lungs. One case showed small necrotic areas in the glomeruli. Culturing and smears of the total urine excreted for 20 days failed to reveal the presence of tubercle bacilli.

In 8 cases cantharidin nephrosis, mercurial nephrosis, and uranium nephritis were produced, and tubercle bacilli were then injected intracardially. Subsequent culturing and smears of the total urine excreted for a number of days failed to show the presence of tubercle bacilli.

In spite of careful histological study of the kidneys, the bacilli were surprisingly absent from the tissues. They were to be seen in specific lesions in only 3 of the cases. In no case were they seen in the lumen of a renal tubule or in the epithelium.

DEDUCTIONS

A critical study of the experimental literature on non-tuberculous bacilluria reveals that bacteria do not pass through the kidney before severe chemical and mechanical injury to the organ has occurred. This manifests itself in the rupture of blood vessels, a severe degeneration of the epithelial cells, and in some cases a glomerulonephritis. A physiological process of excretion evidently does not occur. The appearance of the organisms in the urine depends upon their virulence and their number in the blood. The studies of Koch have shown that some virulent staphylococci may appear in large numbers in the renal tubules. Orth and others also noticed this and called attention to the fact that such organisms may be carried with the urinary stream to the medulla of the kidney, where they may give rise to the development of abscesses (nephritis papillaris mycoticans). Orth, however, mistakenly believed that the organisms found their way into the tubules by a physiological process of excretion by the glomeruli.

By analogy numerous authors have assumed that the same conditions apply to tubercle bacilli. Some believe that these

presence of larger particles in the bacillary suspensions, which allowed the organisms to lodge in the kidney. Pels Leusden injected tubercle bacilli into the renal artery of goats with the following results: (1) The injection of virulent organisms resulted in the development of a generalized tuberculosis (mainly pulmonary). (2) Injection of virulent organisms suspended in olive oil resulted in the development of a unilateral renal tuberculosis and a generalized tuberculosis. The other kidney was not involved. (3) Injection of a smaller number of avirulent organisms suspended in olive oil resulted in the development of a localized unilateral renal tuberculosis.

His conclusions were that: (1) The virulence of the organism plays an important rôle in the development of a renal tuberculosis. (2) Local factors such as circulatory changes and trauma (embolism) play an important rôle. (3) Medullary foci are due to infection of the medulla by organisms which have been excreted by the glomeruli (Orth and his school). (4) Single organisms and smaller particles containing organisms pass through the circulation of the kidney to lodge in other organs (liver, spleen). Only larger particles tend to lodge in a smaller artery and to produce the conditions which allow the development of a renal tuberculosis. (5) In hematogenous renal tuberculosis the lesions seem to prefer the renal cortex.

Friedländer likewise believed that local circulatory changes played an important part in the infection of the kidney by tuberculosis. He likewise believes that the virulence rather than the number of the organisms was responsible for the formation of tuberculous lesions in the kidney.

Bronhorst and Tenseloo believed that tuberculous lesions in the medulla of the kidney might be the result of infection carried by the lymphatics from the bronchial lymph nodes. This theory has been disproved and is no longer accepted today.

De Kersmaecker believed that tubercle bacilli acting upon the tissues can produce a non-specific inflammatory change in the kidney without the formation of specific lesions. He calls this condition a "tuberculo-bacillitis."

Orth believed that isolated medullary renal foci might possibly develop as a result of infection by tubercle bacilli which had been excreted by the glomeruli and tubules and were carried in the lumen of the latter to the medulla or the papilla. But he brings no histological proof of this assertion.

Buday injected suspensions of tubercle bacilli into the carotid vein and into the renal circulation of rabbits. The animals were subsequently killed at varying intervals from a few hours to several weeks after the injection. The kidneys were carefully examined by serial sectioning, and the progressive development of the lesions was carefully studied. In one case he found tubercle bacilli in a renal tubule. But the glomerulus belonging to this tubule was the seat of an extensive tuberculous process. In the first few days the tubercle bacilli produced an

inflammatory reaction in the interstitial tissue. Numerous polymorphonuclear leucocytes and some large wandering cells were seen. Fragmentation of these phagocytic cells soon occurred, and a proliferation of the tissue cells to form the specific tuberculous lesions followed.

Medlar was the first to carry out careful examinations of the urine and to combine these with a histological study of the kidneys. His painstaking and accurate studies have done much to clear up the previously accepted, erroneous views on tuberculous bacilluria. In 1924, this author injected human tubercle bacilli subcutaneously into guinea pigs, and bovine tubercle bacilli intravenously into rabbits. The animals were placed in metabolism cages and the urine was examined for a number of days or weeks by smear and guinea pig inoculation. The kidneys were examined histologically and some of the sections were examined for tubercle bacilli. The rabbit urines all proved to be negative. Five of the guinea pigs gave positive results in the urine and in each of these cases specific tuberculous lesions were found in the kidneys. The guinea pigs lived from 63 to 145 days.

In most of our experiments we injected the bacillary suspensions directly into the left ventricle of the heart. In this way the organisms are immediately disseminated into the greater circulation and are carried directly to the kidneys. Subcutaneous and intravenous injections are for the most part not entirely satisfactory for excretion studies. Following subcutaneous injections the appearance of the organisms in the blood stream is uncertain and delayed at best. After intravenous injections the bacilli are apt to be filtered off in the capillary bed of the lungs.

EXPERIMENTAL DATA

We used female rabbits in our experiments. The tubercle bacilli were injected into the ear vein or into the left ventricle of the heart under perfectly sterile precautions, after which the injection site was treated with tincture of iodine. In some cases intravenous infusions of glucose solution, subcutaneous administration of physiological salt solution, or injections of euphylin were given to stimulate diuresis. The animals were then placed in metabolism cages, which allowed a collection of the total urine voided. These cages had previously been cleaned with boiling water. The total urine excreted was collected for periods up to 30 days. It was completely centrifuged and cultured for

SUMMARY OF EXPERIMENTS—Continued

Rabbit	Injection†	Chemical examination of the urine‡	Smears and cultures of total urines	Histology	Remarks
20	10 mgm. uranium nitrate and 1 c.cm. of 1:1000 adrenalin subcutaneously 3 days later 6 billion virulent human type bacilli intracardially or 75 gm. euphylin subcutaneously	Albumen, trace Specific gravity, 1031	Negative	Glomerulonephritis. No bacilli or specific lesions in kidney	Died 30 hours after second injection
21	3.5 mgm. uranium nitrate and 1 c.cm. 1:1000 adrenalin solution subcutaneously 3 days later 4 billion virulent bovine type bacilli intracardially	Albumen, positive Specific gravity, 1017	Negative for 4 days	Nephrosis. No specific lesions or tubercle bacilli in any organs	Died 10 days after second injection
22	1 mgm. cantharidin subcutaneously 2 days later 4 billion attenuated human type bacilli intracardially	Albumen 1.5% Specific gravity 1030	Negative	Nephrosis. No bacilli or lesions in any organs	Died 22 hours after second injection
23	20 mgm. bichloride of mercury subcutaneously 5 days later 6 billion virulent human type bacilli intracardially	Albumen negative Specific gravity, 1012 granular casts 2-4 erythrocytes	Negative for 4 days	Necrotic nephrosis. No bacilli or specific lesions in any organs	Died 4 days after second injection
24	10 mgm. bichloride of mercury subcutaneously 5 days later 6 billion virulent human type bacilli intracardially	Albumen, 0.5% Specific gravity 1045 1-2 hyaline casts 2-3 erythrocytes	Negative for 3 days	Necrotic nephrosis. No bacilli or specific lesions in any organs	Died 3 days after second injection. Pregnant
25	3 mgm. bichloride of mercury subcutaneously 5 days later 6 billion virulent human type bacilli intravenously	Albumen positive Specific gravity 1037	Negative for 5 days	Necrotic nephrosis. Numerous tubercles in lungs and tremendous number in kidneys. No bacilli	Killed 20 days after second injection. Pregnant
26	10 mgm. cantharidin subcutaneously 4 days later 3 billion virulent human type bacilli intracardially	Albumen positive Specific gravity 1025 1 hyaline cast	Negative for 10 days	Nephrosis. Numerous tubercles in liver, lungs and kidneys	Killed 24 days after second injection

†The uranium nitrate and the bichloride of mercury were given as 1 per cent aqueous solution and the cantharidin as a 1 per cent solution in olive oil.

‡Very careful daily chemical and sediment examinations of the urine were made to demonstrate the presence of renal damage following the injections of the various solutions. For the sake of brevity only the positive findings in the urine on the day of the bacillary injection are indicated.

the renal tissue and give rise to a tuberculous lesion. Such a process in which the bacilli are excreted by and then attack the tissues of the organ has been referred to as an "excretion tuberculosis" (*Ausscheidungstuberkulose*). But these authors have failed to take into account the specific nature of the tubercle bacillus. As Huebschmann has shown, the tubercle bacillus assumes a special position by virtue of the following characteristics: (1) its immediate action upon the tissues is comparatively mild, (2) the tissues are very resistant to the organism, (3) the organism is very resistant to all attempts on the part of the tissue cells to destroy it, (4) it grows very slowly. *It is, therefore, our opinion that, as a result of these qualities, the passage of large numbers of tubercle bacilli through the renal circulation does not result in such immediate, severe, chemical, and mechanical damage to the kidney as to allow their passage into the urine.* In corroboration of this, the histological studies of Maffucci (after the injection of huge numbers of attenuated bacilli), the studies of Jasienski,

the studies of Buday, and our experiments failed to show blood vessel rupture and other such severe changes as Koch, Opitz, and Pernice and Scagliosi found in the kidneys in their studies with non-tuberculous organisms. *We, therefore, believe that by virtue of this failure to produce such changes, the tubercle bacillus does not pass through the kidney, from the blood into the urine, under any conditions.*

Tubercle bacilli may appear in the renal tubules. But this is a very rare occurrence, and it is always dependent upon the presence of specific lesions in the renal tissue which extend to the lumen of the tubule in which the organisms appear. In animals, tubercle bacilli have never been found in the tubules sooner than 8 days after the injection of the organisms into the renal circulation, in other words, not until time has been given for specific lesions to develop. In one case of Buday organisms were found in a renal tubule 9 days after the injection, but the corresponding glomerulus was involved in an extensive tuberculous process. Likewise in a case of Pels Leusden tubercle bacilli lay in a tubule

SUMMARY OF EXPERIMENTS

Rabbit	Injection	Dose	Smears and sections of total organs	Etiology	Results
1	6 billion virulent human type bacilli into ear vein	50 c.c.m. physiological salt solution and 50 gm erythrin intravenously	Negative for 30 days	Numerous small tubercles in lungs	Killed 30 days after injection
2	6 billion virulent human type bacilli into ear vein	50 c.c.m. physiological salt solution and 50 gm erythrin intravenously	Negative for 30 days	Numerous small tubercles in lungs. Few liver tubercles	Killed 34 days after injection
3	6 billion virulent human type bacilli into ear vein	60 c.c.m. physiological salt solution intravenously	Negative for 30 days	Few tubercles in lungs	Killed 34 days after injection
4	6 billion virulent human type bacilli into ear vein	60 c.c.m. physiological salt solution intravenously	Negative for 30 days	Numerous tubercles in lungs. Several small tubercles in cortex of right kidney in one of which numerous streptococci-like degenerated forms of tubercle bacilli	Killed 37 days after injection
5	6 billion virulent human type bacilli into ear vein	60 c.c.m. physiological salt solution intravenously	Negative for 30 days	No specific lesions nor organisms in any organs	Killed 38 days after injection
6	3 billion virulent human type bacilli into ear vein	5 c.c. 40% glucose solution intravenously 50 c.c. physiological salt solution intravenously	Negative for 30 days	No specific lesions nor organisms in any organs	Killed 39 days after injection
7	3 billion virulent human type bacilli into ear vein	5 c.c. 40% glucose solution intravenously 50 c.c. physiological salt solution intravenously	Negative for 30 days	Few tubercles in lungs	Killed 40 days after injection
8	3 billion virulent human type bacilli into ear vein 30 days later 3 billion human type bacilli intracardially	5 c.c. 40% glucose solution intravenously 50 c.c. physiological salt solution intravenously	Negative for 30 days	Few tubercles in lungs. One large tubercle in heart containing streptococci like degeneration forms of tubercle bacilli	Killed 40 days after last injection
9	3 billion human type bacilli intracardially	None	Negative for 3 days	Nephritis. No bacilli or specific lesions	Killed 13 days after injection
10	3 billion virulent human type bacilli intracardially	None	Negative for 30 days	Many tubercles in lungs, liver, and kidney*	Killed 30 days after injection
11	3 billion virulent human type bacilli intracardially	None	Negative for 10 days	Numerous tubercles in lungs and renal cortex	Killed 30 days after injection. Fragment
12	3 billion virulent human type bacilli intracardially	None	Negative for 7 days	Few small necrotic areas in glomeruli	Killed 3 days after injection. Fragment
13	3 billion virulent human type bacilli intracardially	None	Negative for 3 days	Small areas of round cell infiltration in lungs	Killed 3 days after injection
14	3 billion virulent human type bacilli intracardially	None	Negative for 30 days	A few small tubercles in lungs	Killed 30 days after injection
15	3 billion virulent gallinacae type bacilli intracardially	None	Negative for 30 days	Not done	
16	3 billion virulent gallinacae type bacilli intracardially	None	Negative for 30 days	Not done	
17	3 billion virulent gallinacae type bacilli intracardially	None	Negative for 30 days	Not done	
18	3 billion virulent gallinacae type bacilli intracardially	None	Negative for 30 days	Not done	
19	3 billion virulent gallinacae type bacilli intracardially	None	Negative for 30 days	Not done	

*There were numerous pyral and few medullary tubercles in the kidney. In the necrotic center of one lower tubercle and in the necrotic center of one cortical (renal) tubule numerous streptococci-like degenerated forms of the tubercle bacilli were seen. A few such forms were also found in the adjacent interlobular tissue but none in the tubules or pyramidal cells.

organisms may be excreted by the normal glomerulus or the tubular apparatus to appear subsequently in the lumina of the

tubules, in which they are carried with the urinary stream to the medulla or even to the surface of the papilla, where they may attack

curial nephrosis seemed to have the same effect In 2 such cases, in which the animals lived long enough for specific lesions to appear, the tuberculous lesions were strikingly more extensive than in other cases of similar age in which no such damage had been previously induced

It is our opinion that, after a tuberculous infection has occurred in the kidney, the tubules play an insignificant rôle in the further spread of the process through the organ A true excretion tuberculosis (*Ausscheidungstuberkulose*) does not occur in the kidney In this connection we believe that a distinction should be drawn between a "true" and a "false" excretion tuberculosis in the kidney The latter may be defined as the dissemination of tubercle bacilli into the renal tubules by the spread of an interstitial tuberculous lesion through the wall of the tubule or glomerulus and the subsequent infection of other parts of the kidney by these organisms This sequence of events occurs relatively seldom, while a true excretion tuberculosis (the organisms being excreted by the kidney then attacking its substance) never occurs

Various authors (De Keersmaeker and others) have described non-specific inflammatory changes in the kidney due to the direct local action of the tubercle bacilli upon these tissues But as the studies of Schleussing, Ranke, and Huebschmann on the histology of tuberculosis have shown, changes occur in the early stages of development of a tuberculous lesion which may exactly resemble a non-specific inflammatory focus This is the so called "exudative phase" and precedes the "productive phase" in which the actual formation of the tubercle occurs Buday saw such inflammatory changes (accumulation of leucocytes, mobilization of wandering cells, exudation) in the kidneys of rabbits several days after the intravenous injection of tubercle bacilli A fragmentation of the leucocytes then occurred and the productive phase (proliferation of epithelioid cells to form the tubercle) followed In our experiments we have not observed non-specific inflammatory changes in the kidney following the injection of tubercle bacilli into the circulation

We are, therefore, of the opinion that a true tuberculous nephritis does not exist and that the cases which are so described are either true specific tuberculous lesions which are still in the exudative phase of the process, or inflammatory lesions due to other causes

SUMMARY

1 A physiological excretion of bacteria by the kidney does not occur

2 Some bacteria may pass through the kidney and appear in the renal tubules after severe renal damage in the form of blood vessel rupture, severe epithelial degeneration, or glomerulonephritis has been produced by the organisms and their toxins

3 Tubercle bacilli do not pass through the kidneys, from the blood into the urine, under any circumstances because of the comparatively mild immediate action of that organism on the renal tissues

4 Tubercle bacilli rarely appear in the renal tubules, and then only as the result of a direct extension of a tuberculous lesion through the wall of the Bowman's capsule or the wall of the tubule

5 A "true" excretion tuberculosis never occurs in the kidney, and a "false" excretion tuberculosis occurs relatively seldom Tuberculous lesions in the medulla of the kidney are usually hæmatogenous in origin

6 Previously induced traumatic, degenerative, or inflammatory lesions of the kidney do not make that organ permeable for tubercle bacilli

7 Tuberculous lesions in the renal parenchyma which do not communicate with the renal pelvis seldom if ever give rise to bacilluria

8 The kidney has a peculiar immunity to hæmatogenous infection with tubercle bacilli, because of its copious blood supply and the comparatively large caliber of its blood vessels Tubercle bacilli which are circulating in the blood tend to pass through the circulation of the kidney to lodge in other organs Infection of the kidney occurs only if local disturbances in the circulation or the presence of the tubercle bacilli in larger masses which cause embolism (suspended in fat droplets adherent to debris, or agglutinated masses of

34 days after the injection. But here a tuberculous process could be traced extending from the interstitial tissue to the wall of the tubule. In our experiments we made careful histological studies of the kidneys of the animals which had been killed at varying intervals up to 36 days after the injection. Tubercle bacilli were never found in the renal tubules in spite of the fact that millions or even billions of them had been injected into the greater circulation.

Ernst Meyer from his studies in miliary tuberculosis of the kidney mistakenly assumed an excretion of tubercle bacilli by the glomerulus.

Even if the organisms find their way into the tubules by extension from a tuberculous process in the interstitial tissues (which occurs very rarely) their chance of finding their way into the renal pelvis is very slight, for they may easily lodge somewhere along the long and tortuous course of the tubule.

In our experiments we injected tubercle bacilli of varying number, virulence, and type. We overloaded the circulation in some cases with physiological salt solution. We stimulated diuresis in some cases with eupylin or with glucose. In spite of all of these drastic measures the bacilli did not appear in the urine even up to 20 days after the injection.

Some authors have assumed that previous damage to the kidney may allow tubercle bacilli to pass from the blood into the renal tubules—in other words, that, whereas the normal kidney is impermeable to tubercle bacilli the damaged organ may allow these bacteria to pass through it. Thus various forms of direct and indirect trauma, degenerative changes due to tuberculosis elsewhere in the body (Kjellenther) due to pregnancy (Dérou) due to various intoxications, as well as inflammatory changes (nephritis—Fedorow Wildbols) have been said to make the kidneys permeable for tubercle bacilli. In 8 cases we produced varying degrees of uranium nephritis, mercurial nephrosis, and cantharidin nephrosis before injecting the organisms. The bacilli did not appear in the urine in spite of the previous damage to the kidneys. A number of the animals were

also in various stages of pregnancy but no bacilluria occurred.

But as the splendid studies of Sezari on the morphology of the renal secretion have shown, various degenerative and inflammatory changes in the kidney tend to hinder rather than to favor the excretion by the kidney of various substances which are circulating in the blood. This fact, together with the knowledge that a physiological excretion of organisms by the kidney does not occur leads us to believe that the only previous pathological changes in the kidney which allow the immediate transfer of organisms from the blood stream into the urine, are such as are associated with the actual passage of blood into the urine. If huge numbers of organisms are circulating in the blood, some of them may in this manner find their way mechanically into the urine. But such an occurrence has only a remote theoretical possibility and has no practical, clinical importance, because large numbers of tubercle bacilli circulate in the blood stream only in cases of acute miliary tuberculosis. That organisms may appear in the urine in this manner from the occasional, slight disseminations into the blood from foci of chronic tuberculosis in the body is out of the question.

As the studies of Friedrich and Pels Leusden have shown, the kidney shows a peculiar immunity to infection by the tubercle bacilli by virtue of its rich blood supply and the large caliber of the renal vessels. Thus the tubercle bacilli circulating in the blood are carried through the kidney to lodge in other organs. Only such circumstances which help the organisms to lodge in the kidney will favor the development of a renal tuberculosis. Local disturbances in the circulation, trauma, or the presence of the organisms in larger masses which produce emboli in the kidney (suspended in fat droplets, in masses of debris, or agglutinated masses of bacilli) may play a rôle. Baumgarten in his experiments found that previous ligation of the ureter seemed to favor the development of a renal tuberculosis following the injection of the organisms. *In our experiments the previous production of cantharidin nephrosis and mer*

SPONTANEOUS PYELITIS IN THE RABBIT

AN ASCENDING INFECTION OF THE URINARY TRACT, ITS RELATIONSHIP TO THIS DISEASE IN MAN

HENRY F. HELMHOLZ, M.D., ROCHESTER, MINNESOTA
Section on Pediatrics The Mayo Clinic

THE relationship of bacilluria, cystitis, pyelitis, and pyelonephritis of human beings has never been studied, because material for such study has never been available. Ureteral catheterization of patients with bacilluria or mild pyuria is not warranted, and material obtained at necropsy does not give an idea of early lesions, because the diseases rarely, if ever, prove fatal. Very little is known of the etiology of acute cystitis or of acute pyelitis, the existence of the latter as an entity has been denied by Chown and by Wilson and Schloss. The latter authors were unable to find any acute gross, or microscopic evidence of inflammatory reaction in the renal pelvis of children dying of urinary infections. Frank gave observations at necropsy in 11 cases of pyuria due to the colon bacillus. There were no lesions in the renal parenchyma proper in any of the cases. There were lesions of the pelvis in 8 cases, in 1 case the lesions were limited to the bladder, and in the 2 remaining cases, anatomical changes were not found. A similar case, in which lesions were limited to the pelvis of the kidney, was described by Cabot and Crabtree. In my experience, the lesions in the pelvis may be slight as compared with those of the renal parenchyma if a patient dies of pyelonephritis, but usually there are lesions in the pelvis. In commenting on urinary infection, I shall leave out of account those cases in which the lesions in the kidney represent a secondary localization of infection with an organism of the staphylococcus or streptococcus group, and limit myself to infections with gram negative bacilli of the colon-typhoid group.

The lesions produced by the colon group of organisms, in the various portions of the urinary tract, have not been so definitely distinguished, that from the nature of the lesion it has been possible to state whether the organism reached the part by way of the blood stream or by ascent of the tract. The

problem of the mode of infection of the urinary tract of man has remained unsolved and the chances of such a solution being forthcoming at an early date are very slight. It seems, therefore, to be necessary to study these infections in a number of the lower animals so that the various stages of the spontaneous, as well as of the experimentally produced, disease can be followed both bacteriologically and pathologically.

SPONTANEOUS INFECTION

Spontaneous infections have occurred in most of the domestic and laboratory animals: the calf, horse, sheep, pig, dog, rabbit, rat and mouse. A sharp distinction between hæmatogenous and ascending infections has not been made from the pathological picture of the material at hand. Henschen stated that in ascending infection the lesion is more likely to be unilateral; that older changes are found in the lower part of the urinary tract, that there usually is some obstruction to the normal flow of urine, that the changes in the kidney tend to be in the papilla and medulla, but that abscesses in the cortex may be the main lesion in an ascending infection. He did not mention acute pyelitis in the rabbit, only the form of focal nephritis.

Jaffé, under the subheading, "ascending infection (cystopyelonephritis)" called particular attention to the form that occurs in the rabbit following injuries to the spine, giving rise to cord bladder, stasis infection, ascending pyelonephritis, and death. Of less severe infections he said that they may lead to sclerotic changes in the kidney, resembling to no slight degree the changes in the kidney of man. Seifried also mentioned only the severe forms associated with spinal injury, stone, and tumor, but did not describe the uncomplicated form of cystitis and pyelitis which, from more recent experience, I feel cannot be so uncommon.

bacilli) allow the organism to lodge in the renal tissues.

9. *A tuberculous nephritis (a non specific inflammatory change in the kidney due to the direct local action of tubercle bacilli) does not exist*

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TABLE I—CYSTITIS IN RABBITS

Rabbit	Date	Urine						Remarks
		Bladder		Pelvis of left kidney		Pelvis of right kidney		
		Gram negative bacilli	Pus	Bacteria	Pus	Bacteria	Pus	
1	6-16-23	Innumerable	+++	-	-	-	-	Bladder extremely oedematous
2	6-30-23	Innumerable	+++	-	-	-	-	Bladder thickened and oedematous
3	8- 1-23	Innumerable	+++	-	-	-	-	Bladder oedematous
4	4-21-25	Innumerable	++++	-	-	-	-	
5	5- 9-28	Innumerable	++++	-	-	-	-	Epidemic diarrhoea
6	5-20-28	Innumerable	++++	-	-	-	-	
7	9- 7-28	Innumerable	++++	-	-	-	-	
8	10- 6-28	Innumerable	+++					Not killed
9	11-28-28	Innumerable	+++	+	-	-	-	Pneumonia
10	1- 8-29	Innumerable	+	-	-	-	-	Ureters tied 1 hour before animals were killed
11	1- 8-29	Innumerable	++	-	-	-	-	Ureters tied 1 hour before animals were killed
12	1- 4-29	Innumerable	+	+	-	-	-	Severe diarrhoea
13	1-18-29	Innumerable	+++	-	-	-	-	
14	5- 8-29	Innumerable	++++	-	-	-	-	
15	1-23-30	Innumerable	++++	+	-	-	-	Pneumonia
16	4-28-30	Innumerable	+++					
17	5-10-30	Innumerable	++++					

of colon bacilli does not persist in the bladder after bacilli disappear from the upper part of the urinary tract. Spontaneous bacilluria involving the upper part of the urinary tract is exceptional. Since the bacilli do not reach the bladder through the kidney and ureter, it seems probable that they enter the bladder through the urethra or by direct extension from the rectum in the male. A lack of resistance of the mucosa or of the normal washing out of the bladder allows the organisms to grow and to produce a bacilluria. Lowered resistance or increased virulence act to set up an inflammation in the wall of the bladder and to produce cystitis. Seventeen such cases are tabulated in Table I. In 3 of the 34 cases of bacilluria, and in 3 of the 17 cases of cystitis, the urine from the renal pelvis contained organisms but no pus cells. The pelvic bacilluria was bilateral in 3 cases and unilateral in 3. As I interpret these findings, these 6 cases represent the first stage in the ascent of the infection from the bladder to the kidney, for there was bacterial contamina-

tion of the pelvic urine, but no inflammatory reaction of the pelvic lining.

Finally, there are 16 cases of infection of the upper part of the urinary tract (Table II) of which 11 are cases of simple pyelitis in which the pelvis and the pelvis alone was the seat of infection. This represents the second stage in the ascent of the infection, in which there is an inflammatory reaction of the pelvic mucosa to the bacteria.

I want to emphasize this group in particular, because the occurrence of inflammation limited to the renal pelvis has been doubted by some observers, in fact, secondary involvement of the renal pelvis in cases of pyelonephritis has been questioned. Numerically more than twice as common as spontaneous pyelonephritis, secondary involvement was present as a primary factor in probably all but 1 of the 5 cases of pyelonephritis.

Infection of the renal parenchyma from the pelvis takes place rapidly when there is stasis, but the parenchyma may remain uninvolved for many days even in the presence



Fig. 1 Simple pyelitis



Fig. 2 Pyelonephritis

Since 1916 I have been studying the colon bacillus infections of the urinary tract in the rabbit. In 1917 I (6) observed my first case of spontaneous pyelonephritis in the rabbit. The bacillus coli communior isolated from the urine localized specifically in the kidney when injected intravenously and intracystically. In 1922 with Millikan, I cultured the urine of supposedly normal rabbits and found that 20 of 63 rabbits had a considerable number of organisms in each cubic centimeter of urine. The urine of only a few contained sufficient organisms for the condition to be termed bacilluria. "Bacilluria" I am defining as the presence of innumerable bacteria in the urine from the bladder and the absence of pus cells. In the course of the next 5 years, while controlling the sterility of the urine in animals previous to experiment, I (4) encountered 34 rabbits with bacilluria, and 4 with an infection of the urinary tract. All but 1 of the rabbits had an infection with gram negative bacilli. Since 1927 I have had the opportunity to study 29 additional spontaneous infections of the urinary tract of rabbits. No account was kept of the number of instances of simple bacilluria observed during this period.

There are, therefore, available for study 34 cases of bacilluria, of which in all but 3 urine from the renal pelvis was sterile on culture. In addition, there were 33 cases of pyuria, of these, in 27 (Table I) there was cystitis, and in 16 (Table II) pyelitis or pyelonephritis, or both. In 3 of the instances of cystitis, bacilli

were found in urine obtained from the renal pelvis at necropsy. Of the group of 16, 11 were cases of simple pyelitis (inflammatory reaction limited to the lining of the pelvis. Fig. 1) and 5 were cases of pyelonephritis (Fig. 2) in all but 1 of which there was evidence of extensive pelvic inflammation. In 1 of the 16 cases of infection of the upper part of the urinary tract the lesions were unilateral. Of the whole series of urinary cultures gram negative bacilli were grown in all but 1, and in this one a staphylococcus was isolated. In another instance, a staphylococcus was grown from a cortical abscess in the kidney but only colon bacilli from the urine of the bladder.

This group of 67 animals, 34 with bacilluria and 33 with pyuria, represents a more complete series of the various stages of urinary infection than is anywhere available at the present time. In my series of cases of simple bacilluria, reported in 1928, those in which bacilli were found only in the bladder were ten times as numerous as those in which organisms were also found in the renal pelvis. Since 1928 I have not kept track of instances of simple bacilluria, but have tabulated only the instances of pyuria. In spite of omission of these instances, analysis of these 67 cases shows that bacilluria limited to the bladder was the most common spontaneous pathological condition found in the rabbit.

According to previous experiments (3), bacilluria produced by intravenous injection

TABLE II—PYELITIS OR PYELONEPHRITIS OR BOTH IN RABBITS

Rabbit	Date	Died or Killed	Cystitis	Periurethritis	R—Right L—Left	Pus in pelvis	Pyelitis			Per pelvic infiltration	Pyelonephritis		Remarks
							Mucosal infiltration				Papilla	Cortex	
							Parietal	Visceral	Papilla				
1	3-3-17	D	+++	—	R L	++	+	—	+	—	+++	+	
2	6-30-23	D	++	++	R L	+++	+++	++	—	+++	—	—	
3	1-9-25	K	—	—	R L	+	++	—	—	—	—	—	
4	3-28-27	K	+	—	R L	+	+++	++	+	+	—	—	
5	6-26-28	D	—	+	R L	+	+++	+	+	+++	—	—	
6	6-26-28	D	++++	++	R L	+	+++	+	—	++	—	—	
7	6-26-28	D	+	—	R L	—	++	—	+	—	—	—	Chronic inflammation of the pelvis
8	8-25-29	D	++	—	R L	+++	+++	++	+	+	—	++	Single group of abscesses right kidney
9	5-6-30	D	++	—	R L	+++	+++	++	+	—	—	—	
10	2-2-31	D	++	—	R L	—	+	+	++	—	+++	+	Glomerulitis
11	2-9-31	D	+	+	R L	+++	+++	++	+	+++	++	—	
12	4-6-31	K	—	—	R L	+++	+++	+++	++	+	—	—	
13	7-7-31	K	—	+++	R L	++	—	++	+	—	—	++	Staphylococcus
14	10-15-31	D	—	+++	R L	+	+++	—	—	+	—	—	
15	10-3-31	K	—	—	R L	+	+++	—	—	—	—	—	
16	9-30-31	D	—	—	R L	+	+++	—	—	++	—	—	

Summary*

Positive	10	6		16	16	10	11	10	5	5	
Negative	3	4		0	0	6	5	6	11	11	
Number of sections	3	6	Uni lateral		7	4	6	7	2	3	

*Organisms isolated from urine colon bacilli in 16 instances and staphylococci (from abscess of the kidney) in 1 instance

the lesions of the various parts of the urinary passages and of the kidney. It is evident from this that in all but 1 instance (Case 10) there is a definite inflammatory reaction in the lining of the parietal pelvic wall such as is seen in the diagram of ascending infection (Fig 3, e). If the case with the staphylococcus abscesses of the cortex (Table II) is left out of account, there are only 4 cases in which there is any infiltration, local or diffuse, in the cortex, medulla, or papilla. This pyelonephritic group, although small, is of interest because it overlaps into the hæmatogenous

group. In 1 of the 4 cases the localization and extent of the lesions indicate definitely hæmatogenous origin (Case 10) and in 1 case, definitely ascending origin (Case 8), the latter representing an exact duplicate of Figure 3, f, which represents an ascending infection with but a single group of abscesses in one kidney. In the 2 others of the 4 cases, the infection is probably ascending, the 1 because hydronephrosis has probably resulted in the diffuse pyelonephritis and the other because of the slight cortical involvement, the intense pelvic inflammation, and marked infiltration

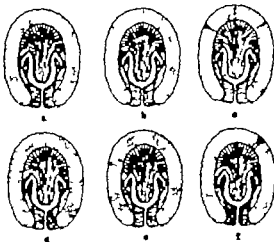


Fig. 2. Hematogenous infection. a, Subepithelial infiltration of papilla. b, abscesses of papilla. c, medullary and cortical abscesses. d, ascending infection. e, Infiltration of parietal pelvic wall and peripelvic fat. f, Infiltration of both pelvic walls and freedom of kidney substance from infiltration. 1, solitary abscess of kidney and peripelvic infiltration.

of severe infection. In only 1 of the cases of pyelonephritis was there a suggestion of stasis. In Case 1 (Table II) there was slight bilateral hydronephrosis and slight dilation of the ureter in its upper two-thirds. In Case 11 (Table II) the inflammatory reaction of the pelvis was in excess of that of the kidney. There are 2 other cases to be considered excluding the 1 of staphylococcus infection. In one of these 2 remaining cases (Case 10 Table II) the pelvic changes were minimal and the lesions in the cortex limited to acute inflammatory lesions in the glomeruli with intertubular infiltration in the medulla. In the other of the 2 remaining cases (Case 8 Table II) there was a single large group of cortical abscesses extending through the medulla and marked pyelitis in the one kidney and simple pyelitis in the opposite kidney.

Considering the question of mode of infection in this series of 67 cases for just a moment the assumption of primary hematogenous infection of the urinary tract would involve passage of bacteria through the renal pelvis and ureter to the bladder with the development of local bacilluria and pyuria. The infection once established in the bladder would then have to return by the ascending

route through the pelvis to the kidney. Such an assumption is not attractive. The nomenclature suggests, as a logical interpretation a primary infection of the bladder, ascending from the bladder through the ureters to the pelvis and from there to the renal substance proper. The frequency of reapposition of urine from the bladder into the ureters makes this the most likely mode of ascending infection, in spite of the occasional finding of para ureteral infiltration.

EXPERIMENTAL PYELITIS

The deductions strongly suggested by the pathological changes observed in spontaneous pyelitis, and by their distribution frequency receive strong support by comparison with a series of lesions produced experimentally in 46 rabbits by injection of colon bacilli into the blood stream or the bladder. The kidneys of 20 animals with hematogenous infection and of 13 with ascending infection were studied and the lesions diagrammed.

The characteristics of the hematogenous infections were (1) bilateral diffusely scattered abscesses of the cortex or medulla, or both (2) localization of the inflammatory reaction in the pelvic lining of the papilla and adjacent mucosa and (3) absence of inflammation in the peripelvic fat. This is well illustrated in a combination of the diagrams taken from the 1922 publication (Fig. 3).

The characteristics of the ascending infection were (1) constant and intense infiltration of that part of the parietal wall of the pelvis that covers the vessels entering the kidney (2) freedom from inflammation or abscess of the renal parenchyma and (3) frequent diffuse infiltration of the peripelvic fat. For comparison with lesions of hematogenous origin several diagrams of the ascending lesion are given in Figure 3.

On the basis of these observations, the probable mode of infection often can be determined without difficulty. With 3 exceptions the diagrams made of the spontaneous infections which are not here reproduced are identical with those of the ascending infections (Fig. 3 d e and f). In Table II I have noted

In four series of experiments with more violent organisms, peripelvic inflammation was present in the hematogenous infections.

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THE HYDROGEN-ION CONCENTRATION VALUE OF TANNIC ACID SOLUTIONS USED IN THE TREATMENT OF BURNS

STANLEY J SEEGER, M D, F.A.C.S., MILWAUKEE, WISCONSIN

BURNS involving relatively large areas of skin surface constitute an important medical and economic problem. While the profound changes produced in the body by these accidents have, for many years, received the attention of workers in physiology and experimental medicine, the attitude of the profession at large has been one bordering on indifference. Fortunately, the surgical literature of the past few years reflects a renewal of interest in the clinical aspects of this subject, which interest was greatly stimulated by the contribution of Davidson on "Tannic Acid in the Treatment of Burns." The high mortality of extensive burns, the prolonged hospitalization, the frequent occurrence of disfiguring scars, and permanent disability warrant more vigorous efforts for the prevention of these accidents. The campaign instituted by the Milwaukee Children's Hospital, in 1931, which contemplates a sustained educational program aimed at the prevention of burns in children, is an example of what can be done in the social phases of this problem.

Burns are usually classified on the basis of the causative agent and on the basis of their severity. The usual classification of burns into first degree or erythema forming, second degree or blister forming, and third degree or eschar forming leaves some things to be desired, but is probably as satisfactory a clinical classification as can be devised. Two recent attempts at re-classification are of interest. Goldblatt

suggests that burns be classified into scar forming and non-scar forming types. Bancroft and Rogers suggest that the present third degree burns be divided into third and fourth degree, the term third degree being applied to those destroying the epithelium but not destroying the hair follicles while those wherein all of the epithelium and subcutaneous fat are necrosed be characterized as fourth degree burns.

It has long been recognized that the extent of skin surface burned or scalded is of much more importance than the degree of the burn. Methods of estimating the skin surface involved have been inaccurate as can easily be demonstrated by questioning any clinician relative to the amount of skin surface represented by a given region. Berkow devised a satisfactory method of estimating the skin surface involved in burns which should be used generally by clinicians.

The symptoms following the infliction of a severe burn fall into three groups: (1) the period of primary shock, (2) the period of so-called secondary wound shock, (3) the period of repair, which may or may not be associated with infection. The early shock which is observed in practically all extensive burns is traumatic in nature and demands immediate and energetic treatment. Treatment should be directed, first, to the relief of pain, second, to the restoration of body heat, and, third, to overcoming the loss of fluids in the circulation which so frequently occurs. Fluid can best be

TABLE III.—MODE OF INFECTION

Ascending			Hæmatogenous		
Total	Experimental	Spontaneous	Total	Experimental	Spontaneous
	3	16		20	21
Infection of perineal pelvic wall		1	Multiple abscesses	1	low multiplicity
Kidney free from infection	0		Focal pyelitis	17	1
Peripelvic infection	4	6	Subepithelial infection of papilla	17	
Single group of abscesses					

of the peripelvic fat. All of the cases of spontaneous pyelitis, and 1 case of pyelonephritis resemble in histological detail very closely the pathological picture produced by experimental ascending infection. One case of pyelonephritis is definitely hæmatogenous and 2 are doubtful. The spontaneous and the experimental lesions are strikingly compared in Table III.

It seems fair then to state that in the rabbit the infections of the urinary tract with colon like organisms start in the bladder and ascend to the pelvis and the renal parenchyma.

A large number of rabbits have bacilluria limited to the bladder a considerable number have pyuria limited to the bladder a very small number have bacilluria involving also the upper part of the urinary tract, and a relatively large number have simple pyelitis. The numerical grouping of the cases points to an ascending infection, the more so as there is no evidence that bacilluria limited to the bladder is of hæmatogenous origin. Even if it were, the concept of ascending infection from the bladder would still hold.

Furthermore, the lesions seen in spontaneous pyelitis of rabbits coincide most frequently with those produced experimentally by injecting colon bacilli into the bladder. All this offers strong evidence that spontaneous pyelitis results from ascending infection.

If the attempt is made to apply to human beings the conclusions derived from study of this complete series of infections of the unobstructed urinary tract of the rabbit, these facts are confronted. So far as the child is concerned, up to the present time no study of material obtained from operation or necropsy

has furnished a histological picture of the early stages of colon bacillus infection of the urinary tract. There is very little likelihood that the information necessary to determine the mode of infection in man can be obtained without unjustifiable risk to patients. It is, unfortunately necessary to supply this lack of information by observations of animals in which the various stages of spontaneous lesions can be compared with lesions produced at will. Such comparisons suggest strongly the existence of a form of pyelitis that is an infection limited to the pelvis of the kidney as a pathological as well as a clinical entity and that it has its origin in ascending infection from the bladder. Similar observations of other animals would still further justify the assumption of a like mode of infection in man, but it must remain, for the present at least, an assumption.

CONCLUSIONS

1. In the rabbit there is a pathological condition of the kidney properly termed pyelitis.
2. A study of comparative pathology indicates that the usual infection of the renal pelvis with colon bacillus proceeds by the ascending route.

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terest The first relates to the production of a toxin at the site of the burn as a result of protein decomposition by heat It is claimed that the absorption of this altered protein produces the characteristic toxæmia, and Davidson, after reviewing the experimental work which has been done, believes that there is strong evidence in favor of this assumption Some confusion seems to exist relative to the time of occurrence of this syndrome If this theory postulated by Robertson and Boyd and other workers is correct, then it would seem logical that the symptoms supposedly caused by altered protein should appear between the first and fifth days The rise in temperature, secondary anæmia, and exhaustion which appear during the later period of repair are generally attributed to absorption from the large infected surface area

The second line of investigation has to do with a shifting of water in the body as a result of which there may occur a tremendous concentration of the blood and great loss of fluid from the tissues Underhill is a leading exponent of the theory that this change is one of the most significant occurring in the organism during the first few days following a burn Underhill states that in experimental animals it can be demonstrated that a burn involving approximately one-sixth of the surface area of the skin may be accompanied by a loss of fluid to the extent of 70 per cent of the total blood volume in a period of less than 24 hours If the results obtained in his experiments may be applied to man one arrives at rather surprising figures for loss of water A man of 65 kilograms has an approximate blood volume of 5,000 cubic centimeters If 70 per cent of the blood volume were lost to the wounded area following a burn of one-sixth of the skin surface, it would mean a loss of fluid of 3,500 cubic centimeters within a period of less than 24 hours The water reserves of the organism are not thoroughly understood It is possible that all organisms and tissues have the capacity of storing water to a limited extent in the form of what Gamble has called "interstitial water" as distinct from water combined within the cells of the tissues Underhill has shown that there are only a few conditions under which it is possible to cause the tissue cells to

give up their water and there is a certain unknown but presumably definite water limit in the cells essential for the proper maintenance of the physiological rhythm If the cells are forced to give up water to the extent that these limits are exceeded, then the organism invariably dies with great promptness Underhill states further that increased permeability of the capillaries following a burn appears to be in one direction only, namely, from the blood to the tissue fluids From the tissue fluids to the blood there is a decrease of permeability to such an extent that doses of strychnine that will kill a normal animal in 10 minutes if injected under the skin are of no noticeable influence when injected into or under the burned skin Underhill believes that it is unnecessary to postulate a theory based on the existence of a specific burn toxin, but that all of the general symptoms observed may be explained on the basis of anhydremia

Davidson introduced the tannic acid method of treating burns in 1925 Tannic acid was suggested to him because of its similarity to phosphotungstic acid in its property of precipitating protein Because of this action it was assumed that tannic acid would be efficacious in precipitating poisonous material in burned tissue, thereby preventing its absorption In short, a local chemical débridement was sought by its use

Extensive experience with this method of treating burned areas demonstrates that it has many advantages Tannic acid as an initial dressing on a burn relieves pain almost immediately so that it is often unnecessary to administer opiates following the thorough tanning of the tissue The precipitated protein formed provides a protective coating against chemical, bacterial, and mechanical action as well as against sensory and inflammatory irritation The general comfort and easy handling of patients is promoted, the loss of body fluids is prevented, secondary infection, especially in superficial burns, is limited because of lack of favorable material for growth of organisms The protective area of coagulated protein acts as a scaffold for the growth of epithelium One of the important functions of the skin is the mechanical protection it affords by cloaking the body in a complete mantle of



Fig. 1. Rabbit 1. Normal skin $\times 50$



Fig. 2. Rabbit 1. Burned skin. Tannic acid (Merck) 2.5 per cent solution applied; hydrogen-ion concentration value 2.92. $\times 50$

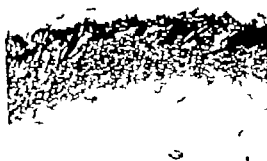


Fig. 3. Rabbit 7. Burned skin. Tannic acid (Zimmer) 5 per cent solution applied; hydrogen-ion concentration value 6.00. $\times 50$



Fig. 4. Rabbit 8. Burned skin. Tannic acid (Zimmer) 5 per cent solution applied; hydrogen-ion concentration value 7.00. $\times 50$



Fig. 5. Rabbit 8. Burned skin. Tannic acid (Zimmer) 5 per cent solution applied; hydrogen-ion concentration value 7.00. $\times 85$

supplied by the administration in large amounts of water and normal saline solution, and by relatively large transfusions of blood.

Two lines of investigation relating to the symptoms which have usually been described as secondary wound shock are of particular in-

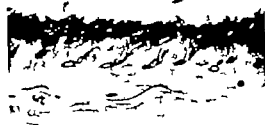


Fig. 6. Rabbit 8. Burned skin. Tannic acid (Zimmer) 5 per cent solution applied; hydrogen-ion concentration value 6.00. $\times 50$

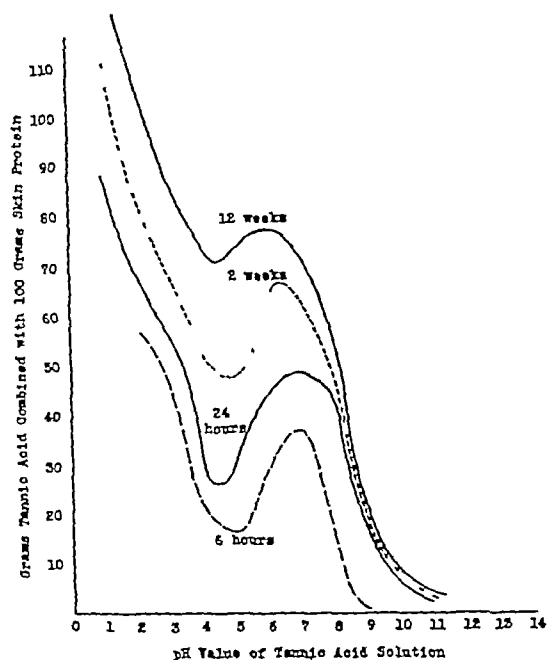


Fig 9 Effect of hydrogen-ion concentration value and time of contact upon the rate of combination of tannic acid with connective tissue fibers of cowhide. Tannic acid 4 per cent solution was applied for different lengths of time at different hydrogen-ion concentration values at temperature of 20 degrees. Note at hydrogen-ion concentration values above 9 the skin tissues became black and began to hydrolyze

tions immediately before use, the ordinary tannic acid powder usually dispensed being the one which has been generally utilized. Lee makes the interesting statement that it has been a practice of the Jews for many years to use ink as a primary dressing on burned surfaces. He believes that the old inks made from tannic gallic acid were very efficient because of a similarity of their action to the tanning of Davidson's method. Our inks are now made from coal tar substances and the similarity no longer exists. He also states that a strong brew of tea makes a tannic acid solution of from about 5 per cent to 7 per cent and he has used it in this manner in dispensary practice.

Inquiry made by me into the experiences of chemists working in the leather industry revealed that it was desirable for clinicians to make further investigation into the properties of tannic acid and the reaction of tissue to it. After consulting Dr. John Arthur Wilson, a

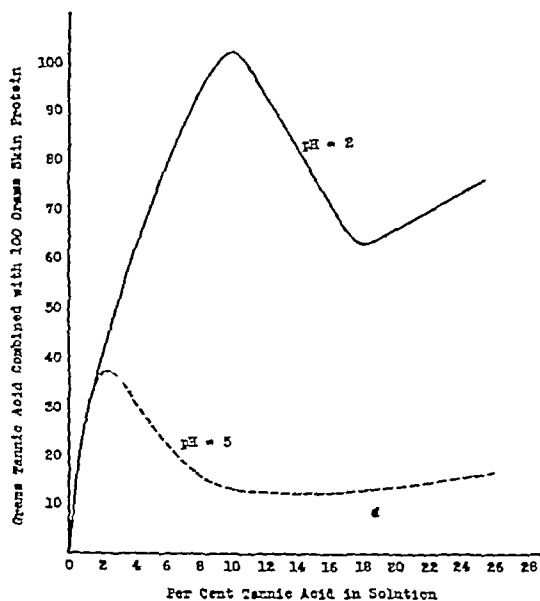


Fig 10 Effect of hydrogen-ion concentration value and concentration upon the rate of combination of tannic acid with connective tissue. Fibers of cowhide in contact with tannic acid solutions of different concentrations for 24 hours at hydrogen-ion concentration values 2 and 5. Temperature 20 degrees C.

chemist of wide experience in leather manufacture, a series of experiments on animals was carried out. These experiments had as their object the determination of the effect of a change in the hydrogen-ion concentration value of tannic acid solutions when used in treating burns. Acknowledgment is hereby made of the valuable assistance rendered to this work by Dr. Wilson.

Wilson states that it is apparent from the wide variety and chemical nature of materials used to tan animal skins and the differences in properties of the leathers produced that no one chemical equation can be given which will cover all tanning reactions. It is possible, however, to generalize. Collagen and gelatin exhibit a marked attraction for water and are readily hydrolyzed. When they undergo chemical changes which markedly decrease their attraction for water and tendency to hydrolyze under a variety of conditions, they are considered to have been tanned. There are probably a number of definite points in the protein molecule where hydrolytic splitting takes place

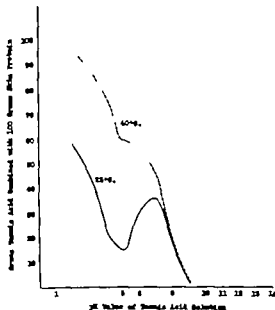


Fig. 7. Effect of hydrogen-ion concentration value and temperature upon the rate of combination of tannic acid with connective tissue. The connective tissue fibers of corneal were in contact with 4 per cent tannic acid solutions (Zimmer) for 3 hours at 25 degrees C and at 40 degrees C.

dead material thus keeping the organism to some extent isolated from its environment. The formation of a crust or scab by tannic acid temporarily restores to the body some of the biological functions of the skin destroyed, thus allowing the organism to readjust itself to altered physiological conditions during a period when the patient is often struggling with shock.

In deep burns, as has been emphasized by Lee and observed by me infection may occur underneath the coagulated membrane. If any signs of sepsis appear the coagulum should be split and portions removed in order to promote drainage. Lee has made a valuable suggestion for the treatment of these deeper burns. During the tanning process he checker-boards the area by making incisions so that 2 inch squares of tanned membrane are formed. This can also be accomplished by laying very narrow strips of adhesive across the burned area and tanning the squares between them.

At the Milwaukee Children's Hospital, we have found the most satisfactory method of

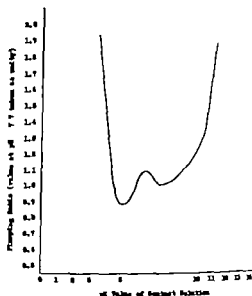


Fig. 8. Effect of hydrogen-ion concentration value of contact solution upon the degree of plumping of perfused calf skin. Different values were applied for 3 days at 7 degrees C. The skin was initially in equilibrium with solution of hydrogen-ion concentration values of 7.7.

applying tannic acid to be the spray the whole area being sprayed every 15 minutes until a firm mahogany brown membrane is formed which usually occurs within 15 or 18 hours. One hundred and fifty patients suffering from burns have been treated by the tannic acid method at the Milwaukee Children's Hospital. The method has many advantages but we have noted no great reduction in the mortality rate. It should be stated here that no one method of treatment meets all of the requirements of every case which one encounters. In fact the treatment of a severe burn requires, in its various stages, a broad knowledge of surgery and a constant reorganization of therapy.

In spite of the fact that the tannic acid method of treating burns has been widely adopted, little attention has been given to the nature of the tanning agent other than to modify the strength of the solutions. Davidson suggested the use of a 2.5 per cent solution and various authors have suggested the use of solutions varying from 2.5 per cent to 10 per cent. All solutions advocated contain only tannic acid and water. Emphasis has been placed on the necessity for making fresh solu-

change becomes more marked because of oxidation of the tannic acid which proceeds at a maximum rate at a hydrogen-ion concentration value of 9. The oxidation products are resinous and very dark in color. The chemical combination of tannic acid and skin tissue is of a distinctly different nature at hydrogen-ion concentration values below 5 than at hydrogen-ion concentration values above 5. After 21 hours the treated areas appeared to undergo no further physical changes until the animals were killed.

Rabbits 1, 2, and 3 were treated with Merck's tannic acid in solutions of 2.5 per cent, 5 per cent, and 10 per cent respectively. The hydrogen-ion concentration values of these solutions, which are the solutions advocated for treatment by Davidson and others, are 2.92, 2.85, and 2.60. Rabbits 5 to 12, inclusive, were treated with 5 per cent solutions of Zinsser's tannic acid to which increasing amounts of alkali were added to produce a range of hydrogen-ion concentration values from 4 to 11.

The hydrogen-ion concentration value of human skin has been extensively studied and is discussed by Cowdry in his text on special cytology. The corneal layer has been found slightly acid, the deeper layers being near the hydrogen-ion concentration of the blood. As cells near the surface die they become more acid, a phenomenon met also in other tissues. The skin, as one of the most important and interesting tissues of the body, is gradually attaining its rightful place in medicine. Its functions apparently are more diverse than has been believed. Cowdry says that until recently, in the dissecting room, the first duty of the student was to get rid of it. Davidson, in his paper on tannic acid, quotes Wiener as stating that the intracellular proteoses which are the supposed toxic agent in burns act only in a faintly acid medium and that their activity is entirely checked by a slight shift to the alkaline side of the neutral point. There has been clinical application of this principle in the widespread use of sodium bicarbonate compresses and baths in the treatment of burns. Therefore, if one accepts the toxin theory of burns, it would seem undesirable to apply to the burned area an acid solution which might favor the action of the toxin.

The great degree of oedema produced in the tissues by solutions in the acid ranges and the marked disruption and disorganization caused thereby are very definitely shown in the microscopic sections. When one proceeds from a neutral to an acid range the suddenness with which this alteration begins at hydrogen-ion concentration value 6 is striking. It would appear that this degree of oedema interferes seriously with the tanning or fixing action of the tannic acid. The most alkaline solution used appears to be much less harmful to the tissues than the slightly acid change from hydrogen-ion concentration value 7 to 6. It is significant that the best results were obtained at the hydrogen-ion concentration value nearest 7.4. The heavy and rapid fixation of tannin and the excessive swelling of the tissues following the use of solutions in the low hydrogen-ion concentration value ranges would in all probability have injured viable tissue were it present. Wilson states that were these acid solutions used to tan skins in the ordinary production of leather, the skins would be ruined. In leather manufacture if the hydrogen-ion concentration value falls below 4 in the early stages of tanning, marked damage to the fibers occurs.

The series of experiments was repeated in twelve guinea pigs, the results confirming those relative to the effect of hydrogen-ion concentration value which were observed in the rabbits. Comments on the photomicrographs here made are those of Dr. Oscar T. Schulz, pathologist at the Columbia Hospital, Milwaukee. From the series of experiments here recorded it would seem that attention should be paid to the hydrogen-ion concentration value of tannic acid solutions used in the treatment of burns. Tannic acid has been used on the theory that it acts as a chemical fixing agent for the destroyed protein, but the evidence of possible injury to viable tissue when acid solutions are used seems to me to be of considerable importance. The deposition of tannic acid is sufficient in hydrogen-ion concentration values near that of the blood effectively to fix tissue which has been injured by heat without producing the oedema which results when acid solutions are used. The uniformity of distribution of tannin and the rate of diffusion are

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or where water or highly ionized molecules may become attached. When a substance combines with the protein at these points and becomes so firmly attached as to prevent any further combining with water or highly ionized molecules the effect is one of tanning and the substance is listed as a tanning material. It is possible of course that the same effect may be obtained through some rearrangement in the protein molecule not involving actual combination with some other material.

The effect of hydrogen ion concentration value of tan liquors upon the fixation of tannin by tissue proteins has been studied in industry by Wilson and others. Variable factors affecting the diffusion of tannins into the skin, such as concentration, temperature and kinds of tannins have also been investigated. Charts 7, 8, 9, and 10 show the effect of hydrogen-ion concentration value and temperature upon the rate of combination of tannic acid with connective tissue the effect of hydrogen-ion concentration value of contact solution upon the degree of plumping of purified calf skin the effect of hydrogen-ion concentration value and time of contact upon the rate of combination of tannic acid with connective tissue and the effect of hydrogen-ion concentration value and concentration upon the rate of combination of tannic acid with connective tissue and are taken from Wilson's text on leather manufacture.

When animals' skin is immersed in dilute solutions of acid or alkali the protein matter swells by absorbing some of the solution. During this process the skin develops an increased resistance to compression which, in the tanning industry, has been given the name 'plumping'. This change, which is dependent upon the water content of the skin, is measured on the basis of the resistance to compression of small pieces of skin under standard conditions. It is generally assumed that the greater yields of leather are obtained when the skin is tanned in a highly plumped condition. If plumping by means of acid is carried to excess the skin will be ruined. Rapid tanning of the surface of the skin occurs, rendering it almost impermeable to the tannin remaining in the solution and left in the interior swell considerably. If left long in this condition especially in warm

liquor the collagen hydrolyzes and the skin is damaged beyond all recovery.

In order to determine the effect of hydrogen-ion concentration value of tannic acid used in treating burns, two series of experiments were conducted. In the first series, 12 rabbits, under ether anesthesia, were burned with a hot iron plate the area covered being a square inches over the right butt, time of contact being 5 seconds, and temperature 300 to 300 degrees C. Immediately after burning, the burned areas were sprayed with tannic acid solution. Spraying was done at intervals of about 10 minutes for 13 hours. After 24 hours, the rabbits were killed and skinned. The burned area from the right side and a corresponding area from the normal left side were prepared for microscopic study. Each rabbit was sprayed with a different solution as follows:

No.	Tannic acid from	Per cent strength	pH value
1	Merck	5	1.90
2	Merck	5	1.95
3	Merck	10	1.95
4	Zimmer	5	2.00
5	Zimmer	5	2.05
6	Zimmer	5	2.10
7	Zimmer	5	2.15
8	Zimmer	5	2.20
9	Zimmer	5	2.25
10	Zimmer	5	2.30
11	Zimmer	5	2.35
12	Zimmer	5	2.40

The first four solutions consisted of pure tannic acid and water. The remaining eight were exactly like number four except for the addition of an increasing amount of sodium hydroxide to increase the hydrogen-ion concentration value to the desired point.

After about 5 hours the color of the treated areas began to darken noticeably the color being darker in the skins treated with the solutions of higher hydrogen-ion concentration value. The effect of hydrogen-ion concentration value upon color is explained by the fact that tannic acid undergoes a molecular rearrangement with the change of hydrogen-ion concentration value the higher the hydrogen-ion concentration value the darker the color of the compounds formed. In this respect tannic acid behaves like litmus, methyl orange, and other indicators of acidity. At higher hydrogen-ion concentration value, the color

change becomes more marked because of oxidation of the tannic acid which proceeds at a maximum rate at a hydrogen-ion concentration value of 9. The oxidation products are resinous and very dark in color. The chemical combination of tannic acid and skin tissue is of a distinctly different nature at hydrogen-ion concentration values below 5 than at hydrogen-ion concentration values above 5. After 21 hours the treated areas appeared to undergo no further physical changes until the animals were killed.

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2	Merck	5	1.25
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5	Zimmer	5.0	2.00
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7	Zimmer	5.0	2.50
8	Zimmer	5.0	2.75
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10	Zimmer	5.0	3.25
11	Zimmer	5	3.50
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undoubtedly promoted by alkalization to a neutral or slightly alkaline point. It is conceivable that the edema which results from the use of acid solutions of tannic acid may augment the shift of fluid from the blood vessels to the tissues which, according to the theory of Underhill, occurs in burns. The studies on the action of tannic acid which have been made by chemists in the leather industry have been made on animal tissues which were not viable. For this reason one may not be able to apply them directly to clinical medicine but it must be conceded that they are of great importance to anyone interested in the clinical use of tannic acid and indicate that sufficient attention has not been paid to the chemistry of the solutions which have been used in burns. Wilson is of the opinion that the action of tannic acid on collagenous connective tissue is probably the same in the living skin as it is in skin which has been removed from the body.

On the basis of this experimental work we have used clinically the following solution of tannic acid: 3.975 grams of pure anhydrous sodium carbonate and 25 grams of pure tannic acid with 500 cubic centimeters of water. This gives a solution with a hydrogen-ion concentration value of 7.4. This solution has been used in two very extensive burns and in both cases gave immediate and late results which, in some respects, were superior to the 5 per cent aqueous solution of low hydrogen-ion concentration value which we used formerly. The tanning occurred rapidly the same analgesic properties were noted, and the tanned membrane which was formed was more pliable than that produced by the solutions in the low hydrogen-ion concentration ranges.

CONCLUSIONS

Tannic acid solutions used clinically in the treatment of burns since Davidson's introduction of this substance are strongly acid and highly astringent, tending to cause swelling and edema of the tissues and a too rapid fixation of tannin at the surface. These disadvantages are overcome by neutralization to the same hydrogen-ion concentration value as that of the blood. Apparently this neutralization is not accompanied by any loss in tanning

power. The beneficial effects of tannic acid observed by clinicians are retained by the use of neutral or slightly alkaline solutions.

In a study of the accompanying photomicrographs an understanding of the changes that have occurred will be facilitated and description simplified by a study of the normal tissue. The tissue in each case includes the entire thickness of the hide of the animal. This consists of the covering epidermis, which is continuous with the hair follicles present in the subepidermal tissue. The latter consists of a rather loosely fibrillated, collagenous connective tissue that contains few nuclei. This rests upon a layer of striped muscle two to three fibers thick, the fibers running parallel to the surface of the hide. Beneath the muscle layer is a thin fascial layer composed of coarse fibers that run at right angles to the muscle fibers. Beneath the fascial layer is loose areolar tissue through which the tissue has been separated in removal.

Figure 1 represents the normal skin of the rabbit in the area in which the burns were produced.

Figures 2 to 6 are taken from the series of photomicrographs made after the experiments described in the text were done. The edema and disruption of tissue with the marked fixation of tannic acid on the surface will be noted in Figures 2 and 3, which were tanned with solutions of hydrogen-ion concentration values of 8.95 and 6.00 after burning of the skin.

Figure 4 represents the condition of the burned skin after tanning with a solution of hydrogen-ion concentration value of 7. Figure 5 being a high power photograph of the same tissue. Nuclear preservation is good and fibrillar structure of the connective tissue is more evident. The decrease in the amount of edema is also notable.

Figure 6 is a low power photograph of burned skin after tanning with a tannic acid solution of hydrogen-ion concentration value of 10. The hide is somewhat thicker than in the normal control from the same animal. The fibrillar structure of the hide is absent, but the nuclei of the hair follicles are well preserved as well as in the underlying in the collagenous tissue fixation of tannic acid on the surface as compared with Figure 4 is evident. Publication of the entire series of photomicrographs is not practicable, but the changes shown are characteristic of those observed as we progressed from the acid ranges to normal hydrogen-ion concentration and from normal hydrogen-ion concentration to alkaline.

Figure 7 is a chart showing the effect of the temperature and the hydrogen-ion concentration values upon the rate of combination of tannic acid with connective tissue at a temperature of 35

degrees C. As the hydrogen-ion concentration value of the solutions increases there is a marked decrease in fixation of tannin with the minimum at hydrogen-ion concentration value 5. Fixation, however, increases reading a maximum at 7, and then falls off to practically nothing at pH=9. At 40 degrees C there is a much greater fixation at all hydrogen-ion concentration values and a steady decrease from pH 2 to 9 with no point of minimum at pH=5. The effect of temperature is undoubtedly very important. At the surface of the skin the temperature is probably very close to that of the atmosphere, but in the tissues below it is probably very close to 37 degrees C.

Figure 8 shows the effect of plumping or swelling of the skin. A piece of calf skin in equilibrium with a solution of pH=7.7 was taken as a standard. Its resistance to compression was measured and the value taken as unity. The measurement was made with a sensitive thickness gauge having a plunger with a base of 1 square centimeter area. The thickness of each piece of skin tested was measured when in equilibrium with a solution of pH=7 and again when the same piece had reached equilibrium with the solutions of some other hydrogen-ion concentration value. The ratio of the second thickness reading to the first was taken as the plumping ratio. It will be noted that the plumping is very great at a hydrogen-ion concentration value of 3.5, decreasing rapidly as the hydrogen-ion concentration value is raised to 5, increasing again slightly with a maximum of 6.5, decreasing again to a minimum at about the hydrogen-ion concentration value of the blood, and then rising again very sharply.

Figure 9 shows the effect of hydrogen-ion concentration value and of time upon the fixation of tannic acid by connective tissue. The entire practical range is covered for tanning periods of 6 hours, 24 hours, 2 weeks, and 12 weeks. The comparison of the 6 hour curve with that of the lower curve in Figure 7 indicates that there is not much to be gained by prolonging the time of treatment of the skin with tannic acid. It is probable that the tannic acid has served its purpose after 2 hours or less of actual contact with the tissues. This period of maximum effect is prob-

ably reached after a longer period when the spraying method is used.

Figure 10 shows the effect of concentration of tannic acid at hydrogen-ion concentration values of 5 and 2. At a hydrogen-ion concentration value of 5, a maximum fixation occurs with a 2 per cent solution of tannic acid. As the hydrogen-ion concentration value decreases, very much more tannin is fixed, and the maximum fixation occurs with the 10 per cent solution.

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BENIGN ANGIOMATOUS TUMORS OF SKELETAL MUSCLES¹

HILGER PERRY JENKINS, M.D. AND P. ARTHUR DELANEY, M.D., CHICAGO

From the Departments of Surgery and Pathology The University of Chicago

TWO HUNDRED and fifty five cases of angiomatous tumors apparently arising primarily in skeletal muscle have been reported in the literature. Most of these have been described as angioma, cavernous angioma or cavernous haemangioma of muscle. Some of the earlier cases were reported as erectile tumors. Davis and Kitlowski² have made the most complete recent review of the literature and reported 11 new cases making their total 212. There are 18 cases in their review which we have not included and we are adding 61 not mentioned by them summarized in tabular form (Table III). We have 1 new case to add to the literature, which makes a total to date of 256.

Woman, aged 22 years, had noticed a mass in her right buttock for the last 9 years which she thought had been gradually increasing in size. Pain had been noticed in the region of the mass for the past 5 years, never severe usually a steady ache which came on only following severe exertion, and was relieved by rest. Tenderness was experienced only when there was trauma to the mass. It never interfered with the patient's activity. The family history was negative for any congenital anomalies or tumors.

Examination revealed an essentially normal young woman except for the right buttock which contained a poorly defined, firm smooth rounded mass about the size of an orange. The overlying skin was normal and freely movable. The tumor appeared to be fixed to the underlying tissues just below the right sacro-iliac synchondrosis and could not be differentiated from the upper and posterior part of the gluteus maximus with which it seemed to be continuous. There was no functional impairment. The mass did not change in size, shape, or position on contraction of the muscle. No thrill, pulsation, expansion, tenderness, compressibility or bruit was noted. There was no change in size or consistency when the patient stood or the tumor was compressed. Aspiration was not attempted. X-ray showed a dense shadow the size of a quarter dollar at the level of the sacro-iliac synchondrosis just to the right of the midline of the sacrum. The diagnosis was made of dermoid cyst with calcification.

Operation was performed August 6, 1927, by Dr. D. B. Phenister at the Presbyterian Hospital.

Ethylene anesthesia was used. The incision was made about 6 inches long through skin and subcutaneous tissues over the region of the mass, down to the muscle. The tumor was hard and firm and appeared to lie within the gluteus maximus muscle from which it was not sharply defined. The tumor was removed by dissecting it with the surrounding muscle tissue. All cut surfaces about the tumor poured out blood profusely. The amount of hemorrhage at operation was rather great but it did not at the time appear alarming. The closure was made with drainage.

The postoperative course was rather alarming during the first day. Shortly after returning to her room the patient appeared to be in shock, with a very weak but slow pulse, air hunger and a systolic blood pressure of 34. A hyperosmotic solution of 1500 cubic centimeters of normal saline solution was begun immediately. Her condition gradually improved and her blood pressure was up to 105 by evening. On the following day her previously normal haemoglobin and red count had fallen to 48 per cent and 3,000,000 respectively. She apparently had suffered a severe hemorrhage. The wound healed without infection or hematoma and the postoperative course except for the first day was uneventful. On examination a year later the patient was in good health and there was no evidence of recurrence or disability from the operation. A letter from the patient 2 years after operation reported that she was in excellent health and that there was no evidence of recurrence of any symptoms. Another letter 4 years and 8 months after operation stated that she was in excellent health, married, and mother of a robust year old daughter. She has had no recurrence of the tumor or any pain. Occasionally she has a feeling of a "strain" in that region.

Gross description of specimen. The specimen measures 7 by 6 by 4 centimeters and weighs 130 grams. Its outer surface is made up of coarse muscle fibers, a small portion of tendon, connective tissue and fat. The mass is of a generally firm consistency. When cut into the outer muscle layer is found to be thin, averaging 1 to 2 millimeters and at some exceptional places as thick as 5 to 10 millimeters. Under the thin muscle covering and forming the largest part of the specimen is a yellowish white, firm tissue with distinct trabeculae of lighter connective tissue. The more yellow firm tissue between the trabeculae contains many blood vessels and spaces and to the touch presents the consistency of rubber. The lumen of the blood vessels is wide, from 2 to 3 millimeters in diameter. On the surface where the tumor tissue is in contact

Davis, J. S., and Kitlowski, E. A. Primary intramuscular haemangioma of skeletal muscle. Arch. Surg., 1929, 25, 26.

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with the skeletal muscle, no distinct capsule is apparent but there appears to be a definite blending of the muscle fibers with the tumor mass. Some of the small arteries in the peripheral fibromuscular tissue are thrombotic.

Microscopic description. Pieces of tissue from various parts of the tumor subjected to different staining methods present a variety of pictures that upon analysis illustrate many of the evolutionary phases of hemangiomatous development in the blood vessels of the muscle and of destruction of the involved muscle. The active pathology includes extensive arteriolar and capillary new-growth as well as definite hyperplasia of endothelium in muscular type arteries and smaller vessels. The skeletal muscle fibers related to such altered blood vessels have undergone a passive but progressive degeneration that is more and more accentuated from the periphery of the tumor toward its center. In Figure 1 there are portrayed, in its left half changes that occur in the skeletal muscle fibers while angiomatous units are still distant. Intermixed among fibers with normal cross section areas of Cohnheim are those whose myofibrillæ have become clumped and the fiber now appears as a homogeneous acidophilic mass. In longitudinal section as in Figures 2 and 6, such fibers show loss of their anisotropic and isotropic discs. The right half of Figure 1 represents the initial invasion of the muscle tissue by angiomatous tumor components that possess histological characteristics of capillaries and small arterioles, these have very little lumen and a proportionally thick wall of one or more layers of cells. Their inner endothelial cell lining is always complete, frequently appearing as crowded nuclei. These vascular channels between muscle fibers always follow the endomysial trabeculae and never penetrate the sarcolemma of the skeletal muscle fiber.

Progress of tumor development and of coincident muscle atrophy is illustrated by Figures 2, 3, 4, 5, and 6. Muscle fibers show loss of myofibrillar individuality followed by lytic changes that eventually reach a degenerative stage represented only by sarcolemma and nuclei. These remnants in cross section resemble giant cells. The proliferation of fibrous connective tissue stroma and of vascular channels is in excess of the amount of muscle destroyed resulting in wide separation of the multinucleated fiber remnants. This is best illustrated by Figure 5. Closely related areas appear under widely different tumor growth control. In Figure 6 there is an encapsulated portion that is very cellular. There are here proportionately more endothelial cells than blood spaces. Individual cell growth, however, does not appear to be excessively rapid. There is neither mitosis nor anaplasia. This tumor portion possesses the only round cell infiltration seen in the many sections studied, and it is very scanty. The contiguous skeletal muscle fibers in contradistinction, show less blood vessel growth than fibrous connective tissue proliferation.



Fig. 1 *a*, Degenerative change in muscle fiber away from angiomatous invasion, *b*, initial invasion of the muscular tissue by angiomatous tumor composed of capillaries and small arterioles.

Beyond the field covered by the photomicrograph there are some fat cells between individual muscle fibers. Intensive degenerative changes, simulating Zenker's degeneration, affect a fair proportion of the muscle fibers in this area, but there are no fatty changes in the fibers themselves.

Proliferative changes affecting well formed blood vessels including two arteries of the muscular type are illustrated in Figures 7, 8, and 9. The artery in Figure 7 has had its lumen filled by the invading angiomatous and stroma tissues. It is interesting to note how, at one point, the neoplastic elements have penetrated and pushed aside a relatively thick tunica media of smooth muscle. One can well interpret that this is the mode of invasion of the tunica media, opposite the point of entrance, and that the vascular element and not the stroma connective tissue is the trail blazer. One observes a triangular space lined by endothelium sending out a pseudopod-like process into the tunica media. The smooth muscle cells of the arteries so invaded by the tumor elements do not give evidence of anywhere near the amount of degeneration that the skeletal muscle fibers experience under more remote relationship to the advancing neoplastic blood vessel.

The muscular type artery in Figure 8 depicts an interesting proliferative change, not inside its lumen but within its wall. The tunica intima has a complete covering of individual endothelial cells, but it is everywhere thickened, and to a very great degree, along one half of the vessel wall (*a* to *b*) where the inner elastic membrane with the smooth muscle cells of the tunica media have become widely separated from the endothelial lining of the intima.



Fig. 2. a, Degenerative change in muscle fiber (loss of anisotropic and isotropic discs) b, Invasion of muscular tissue by angiomatous tumor

through growth of cells that are absolutely unrelated to smooth muscle and that from their morphology and staining characteristics cannot be regarded as fibroblasts. This appears to be tumor tissue of intimal origin. Since a small vessel in Figure 9 shows a type of mural endothelial proliferation that is relatively common it is logical to assume that hyperplasia of endothelium with different potentialities occurs in both the arterial vessels of the parent tissue and in those of the neoplasm. It is likely that such endothelial tissue proliferations and lumen occluding processes, as they diminish or completely shut off blood supply are responsible for the initial degenerative changes in groups of muscle fibers supplied by such arteries but not yet directly invaded by the angiomatous tissue as Figure 1 seems to illustrate.

Pathological diagnosis: arterial hemangioma

RESUME OF TWO HUNDRED FIFTY SIX CASES ETIOLOGY

The age of the patient was given in 216 cases. The largest group was in the second decade which was 80. The age distribution is given in Table I. The age at which the symptoms developed was mentioned in 203 cases. The largest group of 95 fell in the first decade and of these 29 were described as congenital or present at birth. The next largest group was in the second decade which was 67. The fact that 193 of the cases developed symptoms before the thirty first

year shows definitely that this is a tumor beginning in childhood or early adult life.

TABLE I—AGE OF PATIENT AND AGE AT ONSET OF SYMPTOMS

	Given by	Given at onset of symptoms and age
First decade	40	95
Second decade	80	67
Third decade	61	30
Fourth decade	20	7
Fifth decade	9	4
Sixth decade		
Seventh decade		1
Eighth decade		1
Total	26	203

Sex was definitely stated in 204 cases of which 97 were males and 107 females.

With the exception of 6 Japanese and one negro the disease was confined to the white race.

Trauma was mentioned as definitely related to the onset of the symptoms and signs in 36 cases and in 7 others it was a questionable factor. This makes a total of 17 per cent of the cases open to explanation on the basis of trauma.

An hereditary influence does not appear to play any rôle because no two cases were reported from the same family.

There is considerable difference of opinion on the formation of hemangiomatous tumors. Ribbert favors the Cohnheim theory and assumes that angiomas develop from embryonic rests which are separate from the normal tissue. Virchow suggests that the tumors arise as a result of disease of the vaso vasorum and dilatation of pre-existing vessels due to mechanical influence during intra- or extra-uterine life. Rokitsansky thinks that simple hypertrophy of the vascular segments and not neoplastic overgrowth explains the origin of the tumors. Trauma is the important factor according to Lowenthal.

An analysis of the data on the cases reviewed would lead one to believe that a congenital factor must be of primary importance in view of the fact that 95 cases, or 47 per cent of those in which age of onset was given occurred in the first decade 79 per cent within the first two decades, and 94 per cent within the first three decades. Trauma must be considered as a factor of significance



Fig 3 Angiomatous tumor and connective tissue stroma completely replacing degenerated skeletal muscle tissue

at least in some of the cases as our data show that 43, or 17 per cent, are open to explanation on this basis

PATHOLOGY

From the standpoint of gross characteristics of the cases reviewed the tumor has been described as diffuse, circumscribed, or partially circumscribed. The diffuse type was the most frequent. It was mentioned as infiltrating the surrounding muscle from which there was no sharp line of separation in 96 cases. The circumscribed had a sharp line of separation in 34 cases in which half of them had a definite fibrous capsule. The partially circumscribed was described in 12 cases. This type in part infiltrates the muscle, while the rest of the tumor is distinctly separated from it often with a fibrous capsule. In many reports the gross type was not stated.

The circumscribed type rarely involved any structures except the muscle, however, in 2 cases nerves were damaged, and in 2 the tumor was adherent to the periosteum. The diffuse angioma often involved other structures than the muscles. It was necessary to exclude many cases in this review which other authors have included as primary muscle

angiomata because it appeared to us from the report of the case that the angioma probably arose outside the muscle and only involved the muscular tissue secondarily. Even some of the cases which we have included may have been primarily subcutaneous angiomata which involved the muscles secondarily. The diffuse angioma involved nerves in 16 cases, subcutaneous tissue in 10, periosteum and bone in 9, synovial membrane in 7, large arteries in 6, skin in 3, and large veins in 3. The partially circumscribed involved the periosteum and bone in 3 cases.

The color of the tumor was most frequently described as blue or red, and occasionally grey white. In some instances it was dark yellow white, yellow grey, grey streaked with blue, and red blue. The consistency of the tumor was usually soft or spongy but occasionally hard or solid. Fatty tissue was mentioned as making up part of the tumor in 32 cases. Fibrous tissue was described as a component of the tumor in 24 cases. Blood cysts were noted in 5 cases. The consistency of the tumor was usually uniform throughout, but nodular areas varying in size from a grain of wheat to a cherry stone due to phleboliths were often present. Ossification in the tumor was noted in only 1 case.

MICROSCOPIC PATHOLOGY

The reports on the pathology, especially the histological aspects, were fairly good in about 60 per cent of the cases. In 15 per cent it was poor, and in 20 per cent the diagnosis only was given. In 5 per cent no diagnosis was made, histologically or grossly.

The tumors were made up of vascular elements in a connective tissue stroma. The most frequent vascular structure was the cavernous space or lacuna. This was filled with blood the components of which were in the same proportion as in normal blood. The space had a lining of a single layer of endothelium and a wall which was usually thin but sometimes thick, made up of fibrous connective tissue. Arteries of various sizes and especially arterioles were often present. The walls of the arterioles were usually thickened due especially to proliferation of the intima and sometimes the smooth muscle. The

lumen of these vessels was usually narrowed and sometimes even occluded by this process. Veins of various sizes were often present. Capillaries were rather frequently present at some place in the tumor and in a few were the predominating structure. Thrombi in varying stages of organization were frequently present in the lacunae or larger vessels.

The supporting tissue was fibrous connective tissue which varied considerably in its cellular elements. It was in the stroma that the remnants of the striated skeletal muscle fibers were found in some stage of degeneration. In the more central part of the tumor the degenerative changes were usually complete however as the periphery of the tumor was approached the muscle fibers were better preserved and even normal. The degenerative changes seen were atrophy, loss of transverse striations and hyaline and fatty degeneration. Fibroblastic proliferation varied considerably and in some was so extensive that in 6 cases the author considered the possibility of a sarcomatous tumor. Round cell accumulations were frequently present some place in the tumor. Rarely giant cells were described.

The classification of the tumor most commonly used was made from the microscopic picture based on the predominating vascular structure, as cavernous, arterial venous or capillary anglioma according to Muscatello.¹ When a second or third vascular structure was conspicuous the classification included these elements such as cavernous-arterial anglioma. Further modifications of the classification were used when fatty or fibrous tissue was conspicuous, such as lipo-anglioma or fibro-anglioma. Various other terms were used by authors which appeared appropriate to them from the standpoint of descriptive terminology. The most frequently described type was the cavernous which was noted in 143 cases. Of course in this group were many in which other elements were present and even conspicuously so but were not included in classifying the tumor. Other elements which were mentioned were cavernous-venous, 3



Fig. 4. Cavernous structure of angliomatous tumor and connective tissue proliferation.

cavernous and simplex, 2 cavernous capillary 1 cavernous fibrolipoma, 2 cavernous anglioma, 1 and cavernous arteriovenous, 1. In 2 it was called cavernoma and in 1 hemocavernoma and cavernous tumor in 1 which apparently were identical with the cavernous types described by others. The arterial type was described in 4, and in 3 others it was the predominating structure, arterio-cavernous, 1 arterio-capillary-cavernous, 1 and arterio-capillary 1. The venous anglioma was mentioned in 7 cases, and venous cavernoma in 1. The capillary type was diagnosed in 8 and the capillary-cavernous in 4. It was called simple or hypertrophic in 3 and was partly cavernous in another 1. In 12 it was diagnosed just anglioma and in 3 hemangioma. In 9 it was diagnosed erectile tissue or tumor. In 4 it was called a fibro-anglioma, fibrolipo-anglioma in 2 fibromyo-anglioma in 1 and several mentioned in the cavernous group had lipo-anglioma added to the diagnosis. One was called a sarcoma hematoide. In 4 the presence of lymph channels lead the authors to diagnose hemangio-lymphanglioma.

SYMPTOMATOLOGY

The duration of symptoms was most frequently stated as 1 to 5 years, of which

Muscatello, G. *Ueber das primäre Angliom der willkürlichen Muskeln*. Arch. f. path. Anat. u. Path., 1863, 1877.



Fig 5 Area in which the proliferation of fibrous connective tissue and blood vessels is extensive, *a*, marked degenerative change in muscle fibers with only sarcolemma and nuclei remaining, resembling giant cells

there were 74 cases. Twenty-four came to operation within a year, 50 between 6 to 10 years, 36 from 11 to 20 years, 9 from 21 to 30 years, and 1 case did not come to operation for 70 years.

The presence of a tumor mass was the most constant symptom, being present in nearly all cases. A few, however, had no tumor mass palpable and the tumor was found only after operative exploration of the region because of pain. The tumor mass in some cases appeared to arise following a trauma. The development of the tumor was described as slow growing most frequently, however, some enlarged rather rapidly. A few developed slowly at first and later rapidly. This was observed in 13 cases. In 5 cases the tumor was practically stationary in growth for a considerable period and then started to increase in size slowly or sometimes fairly rapidly. In 3 cases the tumor was reported to have disappeared for a time and later returned. In 8 cases the more recent rapid increase in size was associated with the onset of pain which had been absent previously.

The tumor appeared to have a predilection for the muscles of the extremities especially the lower, and particularly the thighs. The



Fig 6 *a*, Degeneration of muscle fiber (with loss of anisotropic and isotropic discs), *b*, very cellular area where there are proportionally more endothelial cells than blood spaces, *c*, fibrous connective tissue capsule

most frequently involved muscle was the quadriceps extensor (See Table II showing frequency of tumor at various sites)

TABLE II—SHOWING FREQUENCY OF TUMOR AT VARIOUS SITES

Trunk		84
Head	22	
Neck	6	
Chest	36	
Back	8	
Abdomen	12	
Upper extremity		64
Shoulder	0	
Arm	22	
Forearm	26	
Hand	7	
Lower extremity		107
Buttock	6	
Thigh	59	
Leg	30	
Foot	3	
Not stated		1
Total		256

In several instances the tumor involved muscles which would overlap in this classification. These cases were listed for the site of most extensive involvement.

The tumor most frequently involved only one muscle, 183 cases. Two muscles were involved in 36 cases, 3 in 9 cases, 4 in 3 cases, and 5 in 1 case. In 24 cases the tumor was described as involving a group of muscles without specifying the particular ones. In 80



Fig. 7 Proliferative changes affecting a large artery
a, penetration through tunica media by neoplastic elements;
b, lumen filled by agglutinates and thrombi;
c, blood spaces sending out a pseudopod-like process into the tunica media.

per cent of the cases however the localization of the tumor was in one muscle only. In 4 cases there were multiple tumors, involving two separate muscles in 3 instances and three in another.

The size of the tumor varied from that of a bean to a child's head. The most commonly described size was that of an egg (38 cases) or a nut (30 cases). The shape of the tumor was more frequently described as oval (87 cases) as compared with round (50 cases). The average dimensions were computed from the actual measurements as well as from measurements of objects which the tumor was described to resemble. The average dimensions for the oval shaped tumors was 5.5 centimeters by 3.5 centimeters, and for the rounded ones 7.5 centimeters. Taking the mean of these dimensions in 138 cases the average diameter would be 5.5 centimeters approximately. In 15 cases the tumor was described as flat topped. In 1 it was hour glass in shape and in 1 sausage shaped. When the tumor was oval shaped the long diameter was parallel to the muscle fibers. The surface of the tumor was more often smooth than irregular. The mass was cir-

cumscribed or sharply defined in about a third of the cases, but was more often diffuse or poorly defined.

The overlying skin was definitely stated to be normal in appearance in 105 cases. In 8 the skin was somewhat bluish over the tumor. In 6 it was described as telangiectatic. A small red discoloration was present in 4 cases. Naevi were present in 2 cases. Dilated veins were overlying the tumor in 3 cases. The skin was ulcerated in 3 cases and the mucous membrane of the cheek in 1 case.

In 160 cases the consistency of the tumor was mentioned. In 64 it was soft, 18 fluctuant, 10 pseudofluctuant, 55 hard, 30 elastic, and 1 hard at the periphery and soft at the center.

The overlying skin was stated to be freely movable over the tumor in 55 cases and fixed in only 6 cases.

On contraction of the muscle the changes observed were fixation of the tumor in 10, increased firmness in 16, increased size in 14, movement of the tumor in 11 and decreased size in 2 cases.

On palpation the tumor was described as tender in 78 cases, compressible in 53, reducible in 51, pulsating in 5, expandible in 1. There was no palpable thrill mentioned in any case report. On auscultation, only 1 was found to have a bruit or souffle.

Changes in the size of the tumor were observed under different conditions. Elevation of the part caused the tumor to become smaller in 12 cases and to disappear in 4. Lowering the part caused an increase in size in 16 and increased firmness in 3. Pressure proximal to the tumor caused it to become more distinct in 6 cases and to disappear in 2. An Esmarch constrictor caused 1 tumor to disappear and 1 to become smaller.

Pain was definitely stated to be present in 144 cases and to be absent in 30. In 27 cases it was the first symptom noticed. In 12 the pain was radiating in character involving the extremity distal to the tumor. In 4 cases a tingling sensation was noticed in the limb beyond the tumor and in 3 cases numbness was noted.

Some functional impairment was observed in 61 cases and definitely stated to be absent

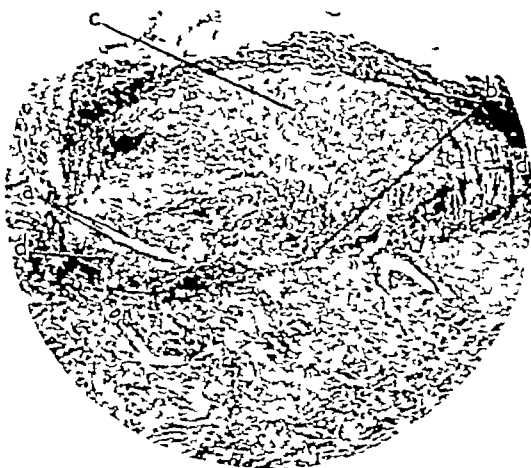


Fig 8 Proliferative changes in wall of a large artery, *a*, thickened tunica intima, *b*, inner elastic membrane pushed away from inner endothelial layer of intima by proliferation of *c*, angiomatous tissue within wall of vessel, *d*, smooth muscle of tunica media



Fig 9 Proliferative changes affecting wall of small blood vessel, *a*, proliferation of endothelium

in 25 cases. Limitation of motion was found in 22, limitation of motion because of pain in 16, limping in 19, and weakness of the involved extremity in 4.

A deformity was observed in 59 cases. A contracture or atrophy of the part was seen 18 times each. A tip-toe deformity was found in 12 cases, nearly all of which were due to a tumor in the muscles of the calf of the leg. In 8 cases the affected limb was larger than the other, and in 3 it was longer.

The general condition of the patient was nearly always described as good. However, 4 patients were described as emaciated, 3 in poor condition, 2 fair condition, and 1 anæmic.

DIAGNOSIS

The diagnosis of this tumor was seldom made correctly before operation. Only 21 case reports mentioned the pre-operative diagnosis as definitely muscle angioma. In 20 other cases the diagnosis of angioma was made without specifying the structure involved. In 6 the diagnosis of a vascular, telangiectatic, or cavernous tumor was made. The points that are of significance in establishing a direct diagnosis are

1 Time of appearance of the tumor 79 per cent in first 20 years and 94 per cent within the first 30 years.

2 Location of the tumor: lower extremities 42 per cent, quadriceps femoris 17 per cent.

3 Tumor mass usually painless, at first developing slowly—size of a nut or egg, usually diffuse and often tender with normal overlying skin, which is usually freely movable over it.

4 Pain which occurs in 58 per cent of the cases some time during the course of the disease.

5 Some functional impairment or deformity which occurs in about a fourth of the cases.

6 When blood is aspirated in an exploratory puncture of the tumor it is of considerable importance in establishing a correct diagnosis. This was done in only 32 cases but it yielded blood in all except one.

7 X-ray examination may be of assistance in making the diagnosis, particularly if phleboliths are found. This was observed in 14 cases. In 10 cases, however, the rays were negative. In 5 there was evidence of calcification in the tumor, and in 3 a periostitis of the adjacent bone was seen. Only a soft parts shadow was seen in 2 cases.

TABLE III—TABULATION OF SIXTY TWO CASES OF ANGIOMATOUS TUMORS ARISING IN SKELETA
MUSCLE SUPPLEMENTING THE TABLE GIVEN BY DAVIS AND KITLOWSKI

[illegible]

TABLE III—TABULATION OF SIXTY-TWO CASES OF ANGIOMATOUS TUMORS ARISING IN SKELETAL MUSCLE SUPPLEMENTING THE TABLE GIVEN BY DAVIS AND KITLOWSKI (Continued)

Author (Surgeon)	Reference	Age Sex	History	Findings muscle involved	Pre-operative diagnosis treatment result	Pathology
12 Cascio	Ann. ital. di chir., 1933, vii 755	10 F	Tumor since birth. Same size until age 10 began to grow especially during puberty. No pain	Size of hen's egg diffuse, slightly reducible. Blood obtained when aspirated. Myloboid, geniohyoid and genio-glossus	Subaponeurotic hemangioma. Incomplete excision and later electrocoagulation. Recovery	Color of red wine. Some places spongy other places fibrous. Made up of blood vessels of varying form and caliber separated by fibrous connective tissue rich in cellular elements. Aside from cavernous structure also areas of new formed blood vessels capillaries showing neoplastic or new-growth activity. Also strands of endothelium-like cells. Degenerative changes in muscle especially at central part. Few foci of round cells. Diffuse cavernous hemangioma of muscle
13 Cevario (Cognozzi)	Pohelin, 1932, xxix, 1654 (ez. prat.)	28 F	Symptoms 2 yrs. Pain right lumbar region radiating	Diffuse tumor 12 cm. diameter pasty compressible, tender. Arching back, tumor more prominent. Blood aspirated. Lumbar muscles	Subaponeurotic angioma-tous tumor of sacro-lumbar mass. Excision Recovery	Blue tumor surrounded by fibrous fatty capsule. Cavities and vessels of various sizes lined by endothelium connective tissue walls. Atypical blood vessel replaced degenerated muscle fibers between the lacunae. Encapsulated cavernous angioma
14 Chauvel and Lecene	Bull. et mem. Soc. nat. de Par., 1911 lxxvi 259	28 F	Symptoms 6 yrs. Weakness of thigh. Pain severe especially at night. Mass appeared few months	Tender elongated mass. Function impaired from pain. Rectus femoris and sartorius	Lipoma. Excision Recovery	Muscle fibers atrophied and disappear following invasion by the angioma. Diffuse intermuscular and intramuscular cavernous angioma
15 Chura and Mikula	Bratislavské lékařské listy, 1925, v 137	8 F	Trauma 6 mos. ago. Mass appeared, slow growing, pain lately. Child pale and weak	Size of goose egg, nodular, tender. Infra spinatus	Excision Recovery	Peripheral part fatty central spongy tissue, the meshes of which were filled with blood. Many phleboliths. Cavernous angioma
16 Chura and Mikula	Same	7 mos	Mass present since birth in right forearm	Soft, size of walnut. Some questionable amount of functional impairment. Flexor digitorum sublimis	Excision Recovery	Blood spaces were small and thin walled. No phleboliths. Cavernous angioma
17 Cuneo	Semana méd., 1924, xxxi 1000 (pt. 2)	8 M.	Mass right arm since 1st mo. of life. Slow growing. Pain occasionally	Size of orange, hard. Contraction of muscle fixes mass. X-ray did not show concretions. Biceps brachii	Excision. Recovery	Reddish tumor encapsulated in muscle. Encapsulated angioma
18 Danielson	Allg. med. Zentr. Ztg. 1909 lxxviii, 487	43 M.	Painful mass on outer side of back. 14 yrs. No change in size	Mass 8 cm. diameter flat, hour-glass shape, compressible, nodular hard areas. Latissimus dorsi	Muscle tumor-lipoma or sarcoma. Excision Recovery	Diffuse cavernous blood cyst-like tumor. Thick fibrous tissue between tumor and muscle. Some muscle degeneration. Phleboliths found. Network of thin walled blood spaces. Cavernous muscle angioma
19 Dieterich	Deutsche Ztschr. f. Chir., 1930 cccxxix, 589	24 M.	Painless mass in cheek for 2 to 3 yrs. Gradual increase in size	Diffuse mass, soft, compressible. Contraction of muscle makes it firmer. Masseter	Cyst of parotid duct. Excision. Recovery	Cavernous angioma with organizing clots and phleboliths
20 Durand	In discussion of case by Moutet, Lyon méd., 1914, cxliii, 321	Small M.	Mass in calf of leg	Hard tumor. Gastrocnemius	Partial excision. Recovery. Several yrs. later tumor had disappeared without further intervention	Tumor looked like fatty liver. Microscopic showed angioma
21 Finaly	Gyógyászat, 1914, liv, 63	5 mo F	Mass appeared when 2 weeks old, growing progressively. Gets larger when crying smaller when asleep	Size of knuckle, smooth, normal skin. Temporal	Excision. Recovery	Hemangioma
22 Finaly	Same	11 M.	Painless mass on back 1 mo	Size of egg disappeared when raised arm. Serratus anterior	Lipoma. Excision. Recovery	Angioma

TABLE III.—TABULATION OF SIXTY TWO CASES OF ANGIOMATOUS TUMORS ARISING IN SKELETAL MUSCLE SUPPLEMENTING THE TABLE GIVEN BY DAVIS AND KILLOWSKI (Continued)

Author (Source)	Reference	Age Sex	History	Findings on necropsy	Pre-operative diagnosis (impaired muscle)	Pathology
1. Finley	Orthopaed. 1914, 17: 86	6 Y F	Had swelling over back and umbilicus since 37 mos.	General non-tumor growth. Pigeon test. Emphysema of 2nd rib. Indolent	Orbital tumor. Excision. Recovery. Emphysema not recurrent	Mass prominence of tumor. Marked tumor at lower. Moderate emphysema.
2. Finley	Case	Y	Palpable mass in back, especially when crying. Colored lump	Soft, fluctuant, tender mass. Gray discolored skin blackened. Tumor in lumbar region	Unknown. Recovery	Tumor black, solid. Rapidly eroded muscle, bone, and vertebrae
3. Cobb	Brit. Med. J. 1913, 2: 1300 July 1, 1913	Young F	Mass in arm	Size of hen's egg. Range brachial	Epithelioma. Recovery	Tumor proved to be in plexus spreading. Patient brought escaped much better and in the end.
4. O'Connell and Rosset	Yeshiva 1911, 1911, p. 122	Y	Mass in lumbar region. Slow growing. Eight years at onset.	Encapsulated in any of muscle 3 cm. For this body muscular and normal except for small areas. No detached fragments. Epithelioma benign and prominent here	Angioma of muscle. Excision. Recovery	Tumor contained the fat, epithelioma like fibroblasts. Cerebral angiosarcoma.
5. Van Haeck	Wien. klin. Wochenschr. 1909, 21: 294	12	Mass many years. Put on diet and still growing rapidly for 2 1/2 years.	Extensive, hard, fibrous mass. Unlikely to be acted by. Osteosarcoma. Epithelioma. Epithelioma. Epithelioma.	Much improvement in operation. Epithelioma. Epithelioma. Epithelioma. Epithelioma.	Primary muscle sarcoma
6. Hansen (Hansen)	Hygiea, 1901, 1901, 292	Y	Mass 2 yrs. Non-painful. Enlarged up arm and down to hand especially thumb and index finger	Size of hand and. Chicken's nose. Area with pale areas. Compartmental growth. In tumor muscle. 6 mm. thick. and yellow like red. X-ray negative. Tumor positive sarcoma	Epithelioma. Recovery. Recurrence of tumor and tumor in the skin	Tumor had thin white outer. Intramuscular sarcoma
7. Hansen (Lange)	Case	10 F	Tumor 2 yrs. age. From mass then. Enlarged up of arm and hand	Mass hard, tender. Tumor hard. Epithelioma. Epithelioma.	Epithelioma. Recovery	Intramuscular sarcoma
8. Brachman	Can. Med. Assoc. J. 1914, 1914, 20	11 M	Mass 2 yrs. age. Slow growing. Eight years at onset.	Hard, but, indolent mass. Size of hand. Chicken's nose. Area with pale areas. Compartmental growth. In tumor muscle. 6 mm. thick. and yellow like red. X-ray negative. Tumor positive sarcoma	Epithelioma. Recovery. Recurrence of tumor and tumor in the skin	Primary muscle sarcoma
9. Brown	Case by Brown, T. A. Medical for the Practice of Surgery, 1914, 1914, 1914	Y	Mass in thigh for 4 yrs.	Mass tumor	Epithelioma. Recovery	Non-compartmental tumor with up of growth tumor and epithelioma
10. Jones (Hansen)	The article	Y	Medical mass for 2 yrs. Hansen's eight years. The growth very slowly	Yellow, hard, smooth, positive growth of tumor. X-ray called. But mass later positive. Compartmental growth. In tumor muscle. 6 mm. thick. and yellow like red. X-ray negative. Tumor positive sarcoma	Epithelioma. Recovery. Recurrence of tumor and tumor in the skin	Epithelioma. Recovery. Recurrence of tumor and tumor in the skin
11. Van Haeck	Wien. klin. Wochenschr. 1909, 21: 294	Y	Developed mass in calf of leg while growing. After had (not in the tumor, pain but not growing) later lost	Tumor very hard. Mass of muscle, and epithelioma. Epithelioma. Epithelioma.	Epithelioma. Recovery. Recurrence of tumor and tumor in the skin	Tumor mass size of egg. Epithelioma. Epithelioma. Epithelioma. Epithelioma.

Surveys are in parentheses

TABLE III—TABULATION OF SIXTY-TWO CASES OF ANGIOMATOUS TUMORS ARISING IN SKELETAL MUSCLE SUPPLEMENTING THE TABLE GIVEN BY DAVIS AND KITLOWSKI (Continued)

Author (Surgeon)	Reference	Age Sex	History	Findings muscle involved	Pre-operative diagnosis treatment result	Pathology
34. Von Khautz	Wien. klin. Wchenschr., 1908 xxx 84	21 M.	Fell striking right thigh. In hospital several mos. Pain since, worse when walking. Mass 2 yrs	Firm compressible mass size of walnut. Movable over femur. Some tenderness on pressure. X-ray negative. Vastus medialis rectus femoris and vastus later medius	Traumatic muscle swelling Excision Recovery	Tumor grayish white tissue. Some relatively large arteries and veins, narrow heavily walled vessels, many thin walled veins, blood filled spaces lined by endothelium, with some connective tissue in walls. In places these are confluent making larger spaces. Connective tissue fibrous but poor in cells. Some tendency to form capsule. Areas of old blood pigment. Foci of round cells. Degeneration of muscle fibers Hemocavernoma
35. König	Beitr. z. klin. chir. 1920 cxx 656	23 F	Pain 1 yr. Swelling 6 mos. Walking made pain worse. Could not fully extend leg	Soft, diffuse, tender tumor 6 cm. diameter with smooth surface. Skin normal and freely movable. Contraction of muscle moves tumor. More prominent when standing. Fixed to surrounding tissue movable over bone. Semimembranosus	Lipoma probably intramuscular Excision Recovery	Greater part of tumor is ordinary lipoma. Other part has cavities of different sizes and shapes lined by endothelium and often containing thrombi in stages of organization. Connective tissue stroma very cellular in places, fibrous in others. Thickening of walls of vessels due to hypertrophy of smooth muscle and also to proliferation of endothelium. Sharp separation of lipoma and angioma. Degenerative changes seen in striated muscle. Lipoma and hemangioma
36. Kuettner	Deutsche Chir., 1913 xxv, 249	25 M	Mass since early youth. Some pain following carrying of pack	Rounded diffuse, tender mass, elastic. Skin red colored, and fixed to mass. Blood aspirated. Latissimus dorsi	Excision. Recovery	Tumor in muscle apparently involved skin and subcutaneous tissue secondarily. Many endothelial lined spaces especially in center. Muscle degeneration. Many large blood vessels. Connective tissue especially at periphery suggested spindle cell sarcoma. Angioma cavernosum and simplex
37. Kuettner	Same	43 M	Mass in back, has stayed about same size. Pain when weather changes	Soft, elastic, nodular mass 8 cm. diameter. Tender. Skin normal and movable. Blood aspirated. Sacrospinalis	Excision. Recovery	Large vascular spaces filled with blood, some thrombi organizing. Some muscle degeneration. Dense connective tissue. Angioma cavernosum
38. Kuettner	Same	10 M	Mass 1 yr. Pain on pressure only	Hard, flat, diffuse, 6x3 cm. Tender. Skin normal and movable. X-ray show thickening of fibula adjacent to tumor. Peronei	Excision. Recovery	Tumor blue-red color. Blood filled spaces with firm connective tissue walls. Hemangioma cavernosum
39. Kuettner	Same	23 F	Fell on hand 12 yrs. ago. Tumor developed, then remained same size	Mass soft, fluctuating, nodular tender. Somewhat compressible. X-ray showed phleboliths. Skin normal. Flexor digitorum profundus	Excision Recovery	Dark red-colored tumor. Cavernous hemangioma
40. Leffi	Osp. maggiore, 1920 viii 119	16 M	Noticed tumor on left side of back	Oval, 5 by 2 cm. Sharply defined, partially reducible, contraction of muscle moves mass. Skin normal and freely movable. Trapezius	Excision. Recovery	Color yellow and parts red. About a third is fat. Phleboliths present. Great number of cavities in connective tissue stroma in which striated muscle fibers altered by degenerative changes. Endothelial lining. Thickening of walls of some blood vessels, especially in tumor. Lumen almost obliterated. Cavernous angioma
41. Leffi	Same	17 M	Mass in left cheek since infancy	Size of hen's egg contraction of muscle fixes it. Reducible. Skin has bluish color. Masseter	Considered angioma, lipoma, or cyst. Excision. Recovery	Tumor fibro-elastic to soft in consistency. Showed muscle fibers separated by cavernous spaces varying in size lined by endothelium. Organized thrombi. Cavernous angioma

TABLE III.—TABULATION OF SIXTY TWO CASES OF ANGIOMATOUS TUMORS ARISING IN SKELETAL MUSCLE SUPPLEMENTING THE TABLE GIVEN BY DAVIS AND KITLOWSKI (Continued)

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the party's power is perpetuated

TABLE III.—TABULATION OF SIXTY-TWO CASES OF ANGIOMATOUS TUMORS ARISING IN SKELETAL MUSCLE SUPPLEMENTING THE TABLE GIVEN BY DAVIS AND KITLOWSKI (Continued)

Author (Surgeon)	Reference	Age Sex	History	Findings muscle involved	Pre-operative diagnosis treatment result	Pathology
50 Piccoli	Riforma med., 1908 xxiv, 1102	17	Mass several yrs. In crease in size 1 yr and pain radiating down leg	Hard diffuse irregular mass size of egg Semiflexion of leg couldn't extend leg Tender Soft in center Gastrocnemius	Excision Recovery	Spongy tissue Cavities of various forms in stroma of connective tissue and muscle fibers, lined by endothelium. New formed capillaries. Muscle atrophied. Elastic fibers. Organizing thrombi. Cavernous angioma
51 Pilatte and Scheikewitch	Bull. et mém. Soc. anat. de Par., 1919 lxxix, 335	8 F	Trauma followed in few weeks by mass	Mass elongated size of orange pseudo-fluctuant, slightly tender Blood aspirated Deltoid	Angioma. Excision. Abundant bleeding Recovery	Tumor made up of mass of cavities with walls of connective tissue. Endothelium hard to find. Apparently partially circumscribed cavernous angioma. Angioliths present
52 Pinardi	Arch. ital. di chir., 1925 xii, 394	4 M	Painless mass in left thigh 5 mos	Elastic pseudofluctuant, lobulated mass. Contraction of muscle fixes it and makes it larger Skin normal freely movable. Thigh 6 cm larger than other Semi-tendinous and biceps femoris	Lipoma or sarcoma of muscle. Excision Extensive venous hemorrhage, (Esmarch) Recovery	Tumor made up of new formed blood capillaries in stroma of hypertrophied connective tissue Vessels of arteriole type. Also cavities filled with blood with incomplete endothelial lining Connective tissue forms part of wall lining In central part stroma about lacunae dense fibrous tissue with scarcity of cells at peripheral part more abundant about the capillaries richer in young cells. No round cells or smooth muscle present. Muscle fibers at periphery relatively normal but in stages of degeneration as central part approached. No thrombi, some fatty tissue. Diffuse capillary and cavernous angioma
53 Porcile	Polichin., 1908 (sez. chir.) xv, 289	11 F	Struck rt. shoulder Mass 2 mos. Pain radiated down arm	Superficial network veins over deltoid region Mass back of shoulder size of large nut, smooth compressible slightly tender Contraction of muscle made it harder Aspirated blood. Incised, hemorrhage. Also found masses in arm and forearm. Infraspinatus triceps brachii, supinator longus	Multiple muscular angioma. Excision of tumors of forearm and back of shoulder Unable to do complete excision of tumor in triceps because of hemorrhage Recovery	Tumor of infraspinatus made up largely of fat. Mostly small venules, also small arteries partially obliterated and capillaries. Triceps-small arteries with obliteration, vascular spaces, with blood and thrombi. Degeneration of muscle. Connective tissue stroma. Fat. Supinator longus—Arterioles mostly, also blood spaces thick walls rich in nuclei. Connective tissue stroma. Multiple muscle angioma
54 Rives and Barras	Montpel. méd., 1911, p 594	17 F	Noticed mass 7 yrs. Mild pain sometimes spontaneous	Hard size of egg Some expansion and tenderness. Present when standing disappears when reclining Rectus abdominis	Paraumbilical hernia. Excision. Recovery	Muscle penetrated by capillaries of the new growth thickened walls. Abundant young connective tissue stroma especially at central part where elongated cells suggested angiosarcoma to authors Also blood cavities present. Obviously cavernous-capillary angioma
55 Saint Pierre	Ann. d., anat. path., 1930 vii, 64	13 F	Painless mass over shoulder blade 1 yr	Soft, defined size of orange. Contraction of muscle fixes it. Skin normal. Trapezius	Excision. Recovery	Encapsulated tumor Blood takes variable sized lined by endothelium. Degeneration of muscle fibers. No thrombi. Cavernous angioma
56 Scarpello	Gazz. internaz. med. chir., 1926 xxxi, 91	18 F	Mass 4 yrs. Pain 2 yrs. following period when stationary in growth then started to increase in size. Radiated up arm	Size of hen's egg with two lobes Compression and elevation of arm reduced size. Unable to adduct thumb Thenar muscles	Primary cavernous hemangioma of muscle	Tumor made up of new formed blood vessels of various forms and dimensions. Lacunae in central part, capillaries mostly at periphery Thickening of walls due to hypertrophy of media and intima. Organizing thrombi Muscle degeneration. Connective tissue stroma. Capillary-cavernous angioma

In the differential diagnosis the most commonly confused tumor was the lipoma which was diagnosed in 21 cases. A diagnosis of neuroma, neurofibroma, or fibroma was made in 10 cases. In 9, cold abscess was mentioned. Sarcoma was diagnosed 7 times, simple cyst 5, dermoid cyst 3, and chronic myositis 3 times. In 3 cases it was merely called a tumor and in 2 it was called a muscle tumor. Tuberculous osteomyelitis was mentioned twice, and tuberculous lymph glands once. Chronic bursitis, hæmatoma, pyogenic abscess, aneurism, and myositis ossificans were each mentioned twice. Other diseases mentioned once were ossifying tumor, foreign body, lymphangioma, malignant tumor, cyst of parotid duct, ganglion, rhabdomyoma.

TREATMENT

In nearly all the cases the tumor was removed by local excision. The circumscribed type was usually easily removed by enucleation. In the diffuse or partially circumscribed, however, it was usually necessary to resect the tumor with surrounding muscle beyond the limits of the tumor. In a few cases the tumor was so extensive that all the angiomatous tissue could not be removed without injuring important structures such as large nerves or arteries. In 8 cases a partial excision was done. Amputation was found necessary in 3 cases. In 4 apparently only a biopsy was done. Electrocoagulation or cautery was used entirely in 1 case and subsequent to partial excision in 2 cases. In 1, radium was used following incomplete excision. In 2, the tumor was merely exposed but not excised.

In 38 cases, the problem of hæmorrhage was of considerable moment as it was in our case. Also in several other cases a troublesome hæmatoma developed after operation.

PROGNOSIS

There was no mention made in the literature of a death due to angiomatous tumors of muscles. There was no report of a mortality from the operative procedure. Recovery was definitely stated in 198 cases. Recurrence of the tumor was observed 15 times, mostly after incomplete removal. The symptoms of pain, limitation of motion, contracture, etc., were nearly always relieved by operation even in some instances when the excision was incomplete. Disability following operation, however, did occur in a few instances. A contracture persisted or occurred after operation in 4, limitation of motion in 3, deformity in 2, atrophy, lump, or loss of function of a muscle in 1 each.

SUMMARY

1. A case of benign angiomatous tumor of the gluteus maximus muscle of the arterial type is reported. A review is made of 256 reported cases. Of these 62 are summarized in tabular form, supplementing the table listed by Davis and Kitlowski.

2. In reviewing the 256 cases, the tumor was found to occur usually before the age of 20 years (79 per cent) and almost always before 30 years (94 per cent). The etiology has not been definitely established, however, a congenital factor has appeared to be of considerable importance, while trauma may have played some rôle in 17 per cent of the cases.

3. The cardinal symptoms were a mass which grew slowly and was localized to a muscle or group of muscles, usually with normal overlying skin, pain which was present at some time in the course of the disease (58 per cent), tenderness (29 per cent), deformity or functional impairment.

Gussenbauer and listed also under his name. The case of tumor in the pectoralis major originally reported by Vincent was operated upon by Ollier. This was listed as a separate case for Ollier cited by Rigaud. Also it appears that through misprint this is the same case of pectoralis major listed for Allier which was cited by Coletti. This accounts for 10 cases. The second case of angioma of the masseter listed for Pantaleoni cited by Kolaczek is no doubt the same case that Pantaleoni originally described although Kolaczek gives data on the case which does not

agree with the original article by Pantaleoni to which he refers. This all accounts for 18 more cases than were actually observed, and corrects the total listed by Davis and Kitlowski to 194. The 61 additional cases which we have found in addition to the one which we are reporting makes the total to date of 256. It is very likely that a more critical review of the literature would rule out a number of cases which we have included especially in instances in which the pathological descriptions are rather sketchy.

SURGERY GYNECOLOGY AND OBSTETRICS

TABLE III.—TABULATION OF SIXTY TWO CASES OF ANGIOMATOUS TUMORS ARISING IN SKELETAL MUSCLE SUPPLEMENTING THE TABLE GIVEN BY DAVIS AND KITLOWSKI (Czechoslovak)

(Author (pages))	Reference	Age Sex	History	Findings muscle involved	Pre-operative diagnosis treatment result	Pathology
17. Rosen	Deutsche Zeitsch. f. Chir., 1904, 222: 117	17 M	Muscle in right thigh 7 yrs. Gray fleshy Pain only in cold weather	Soft, fleshy, also of grayish. Rich normal and irregularly arranged. Compression at neck made it larger. Mammillary	Proved op. Excision. Recovery	Mixed vessels of various size mostly veins, few arteries. Also smaller blood vessels and lymphatics. Connective tissue in intermuscular spaces. Numerous small blood spaces.
18. Tait	Chn. chik., 1902, 21: 1179	17 M	Muscle 7 yrs. slow growing at first, later rapid. Pain getting worse	Encapsulated, 6 cm. size of cyst. Diffuse, soft, fleshy normal, tender, elastic. (Cutting of between and head. Emerged muscle in same position. Tongue bracket	Retrospectively proven. Excision. Recovery	Spangly, no capsule. Connective tissue by infiltration. Arteries, veins, capillaries. Moderate amount of connective tissue. Extensive of adipose tissue. Connective tissue covering ducts and ducts of lymphatic vessels. Almost capsule. Infiltration in adjacent muscle. Dilated overlying epigastrium.
19. Tashkin	Voprosy Med. i Kirurgii, 1901, 21: 117	17 M	Muscle 7 yrs. gradual growth. Pain in groin when working. Sometimes in groin when working long and also gets larger	Size of hen's egg. Reddish and pale in appearance. Rich normal. Compression at neck made it larger. Flattened at base, especially toward the pelvis.	Excision. Recovery	Good number of large vessels. Small vessels surrounded by connective tissue. Epigastrium, overlying epigastrium.
20. Whitney	Lobey mald., 1902, 1: 117	16 F	Limbation and pedunculated masses above 7 yrs.	Muscle showing soft, fleshy, normal, tender, elastic, tender. It appears as a division of the muscle. Connective tissue, especially at neck. Extensive of connective tissue. Thymus	Tuberculosis of the chest. Cold abscess or abscess of the chest. Excision. Recovery. Some portion of the chest. Abscess and hemorrhage	Dark, colored tumor with long yellow covering over it. No capsule. Dilated epigastrium.
21. Yehoud and Bock	Toussaint mald., 1902, 2: 117	19 F	Painful mass slow growing 14 yrs.	Size of hand, soft, hard, compressed. Rich normal and irregularly arranged. Found by compression of neck. Emerged	Excision. Recovery	Tumor appeared blue. Chondro-sarcoma connective tissue.
22. Williams	Longueil, Descriptions, 1800, 1: 117	18 F	Muscle 9 yrs. slow growth. Painful especially when walking	Encapsulated, 1 cm. size. Fleshy, normal, tender, elastic. (Cutting of between and head. Emerged muscle in same position. Tongue bracket	Excision. Recovery	Very vascular. Some connective tissue. Overlying epigastrium.

NOTES ON CORRECTIONS

In going over the original articles quoted by Davis and Kitlowski and Davis' we have several comments to make us that it was rather doubtful that the tumor was an angioma which arose primarily in the muscle, but rather invaded it secondarily. This also includes all cases in which the tongue was involved, because of the frequency of angiomas in processes originating in the mucous membrane of the tongue. The cases so included were those of Rigaud (tongue) Cruveilhier, Beaumgartner and Veron (very extensive involvement of entire limb). There were occasional instances where cases were reported twice because they were listed by the name of the author of the article and also by the name of the surgeon who operated and who may have given a brief report in some obscure journal, or as cited in some other article. In the case of Rigaud, I found the following instances of duplication: Bonnet in These Toulouse, 1894, described fully a case involving the vastus lateralis operated upon by Vastin. Rigaud cited Vastin case in These Paris, 1901. In Mizan's article reporting 3 cases, I was operated on by Bonnet in the quadriceps. Rigaud's thesis. The 3 cases listed for Rigaud were reported by Berger although the latter had the same later mentioned by Rigaud and listed as a separate case. The 3 cases reported by Papov were operated upon by

Davis, J. B. Primary hemangioma of muscle. Bull. Johns Hopkins Hosp., 1902, 20: 74.

CLINICAL SURGERY

FROM THE TUMOR CLINIC, MICHAEL REESE HOSPITAL

THE TREATMENT OF CARCINOMA OF THE CERVIX WITH SMALL QUANTITIES OF RADIUM

MAX CUTLER, M D , CHICAGO

Director of Tumor Clinic, Michael Reese Hospital and Consultant in Tumors Hines Veteran Hospital

THE purpose of this communication is to discuss the principles underlying the radium treatment of carcinoma of the cervix and to describe and illustrate a technique by which small quantities of radium can be used effectively in the treatment of this disease. The technique that is presented is in principle that which is employed in the Curie Institute of Paris. Special attention is directed to the medical and economic advantages of this method as compared with the technique involving the use of much larger quantities of radium.

THE TIME FACTOR

The question of the choice between small amounts of radium applied over long periods as compared with large quantities over short periods has occupied the attention of radiotherapeutists for many years. In addition to the medical aspects of the problem which are of paramount importance, the economic considerations involved also merit serious consideration. Thus, if it can be demonstrated that in order to deliver a total dose of 8,000 milligram hours of radiation 60 milligrams applied for 133 hours is at least as efficacious as 333 milligrams applied for 24 hours, the observation would be of considerable practical importance.

Approximately \$4,200 represents the value of the radium in the former instance and \$23,000 in the latter.

The report of the special committee of the American College of Surgeons on the treatment of malignant disease recommends the establishing of tumor clinics throughout this country and advises the acquisition of at least 200 milligrams of radium for these units. The distribution of the 200 milligrams of radium must be such that the different tubes and needles can be used in the treatment of a variety of lesions, particularly cancer of the skin, lip, tongue, cervix, and breast. It is obvious that even when as much as 200 milligrams of radium are available not more than 80 to 100 milligrams is

in a form in which it can be utilized in the treatment of carcinoma of the cervix.

It is not within the scope of this communication to discuss the various theories that are held upon the relative merits of the two methods of treatment. The French School, centered around the Curie Institute of Paris, maintains that the time interval during which any radiation is applied is of the greatest importance, and their entire technique of radium therapy is built upon the principle that tumor cells are most vulnerable to radiation during their stage of division. In the treatment of carcinoma of the cervix, the lesion is irradiated for approximately 5 days, in the treatment of carcinoma of the tongue for 7 days, and in the treatment of carcinoma of the larynx, pharynx, and tonsil from 12 to 21 days. Regaud is of the opinion that for each type of growth there exists an optimum time for irradiation. In order to obtain a maximum radiation effect the treatment should be given as nearly as possible during this interval. A shorter exposure fails to induce an optimum effect. If the interval of irradiation is prolonged beyond the optimum time, the tumor cells pass from their most sensitive phase to a state of relative radioresistance.

Although there is considerable evidence to support these contentions, this view is not uncontested. Many authorities are of the opinion that this principle has been thoroughly established in the treatment of carcinomata affecting the oral mucous membrane and the more radioresistant forms of skin cancer. It is more difficult to prove the importance of the time factor in the treatment of carcinoma of the cervix. One point, however, is certain, namely, that by prolonging the time of irradiation the normal tissues can withstand much larger doses of irradiation than is possible by short, intense exposures. This fact alone favors the use of the prolonged method of irradiation in cases in which other factors render this technique feasible.

SURGERY GYNECOLOGY AND OBSTETRICS

which were each present in about a fourth of the cases.

4. The correct diagnosis was seldom made before operation (21 cases). The accuracy of the diagnosis was aided by aspiration of blood from the tumor and by the presence of phleboliths in the X-ray examination. The lesion was most often confused with lipoma, sarcoma, or cold abscess.

5. The treatment of the condition was practically always surgical excision which was sometimes technically difficult because of hemorrhage (15 per cent).

6. The tumor occurred most frequently in the extremities especially the lower and particularly the thighs. The quadriceps femoris was the most frequently involved

muscle (43 cases). Grossly it was found to be diffuse most frequently although some were circumscribed or partially circumscribed. Microscopically it was found usually to have a cavernous structure although frequently arterioles, veins, and capillaries were present and sometimes the predominating structure. Definite proliferative changes were observed in the endothelium of the vessels and in the supporting tissue in a considerable number of the cases.

7. The prognosis for life is excellent as there were no deaths reported from the disease or the surgical treatment. Disability following operation was infrequent (5 per cent) and recurrence almost equally rare (6 per cent).

Adenocarcinomata of the cervix are radioresistant and do not respond well to radiation therapy. The epidermoid carcinomata constitute the radiosensitive group, but within this group there exists a pronounced variation in radiosensitivity. The squamous types with marked differentiation, pronounced squamous features, hornification and keratinization are more resistant than the more undifferentiated anaplastic types. The radiotherapeutic procedure is influenced by the histological structure only to the extent of differentiating between the epidermoid and glandular carcinomata.

Adenocarcinoma of the fundus uteri may grow downward, and by presenting at the external cervical canal give rise to the clinical diagnosis of carcinoma of the cervix. Microscopical examination of a biopsy establishes the true origin of the lesion and guides the therapeutic procedure. In extremely early carcinoma of the cervix in which an extensive hysterectomy is sometimes considered, if the histological structure shows a high grade of malignancy (anaplastic type or grade 4 type) the surgical procedure is absolutely contraindicated. With these isolated exceptions the histological structure should not influence the character or extent of the radiotherapeutic procedure.

CLINICAL VARIETIES

The Cancer Committee of the League of Nations (1929) has proposed the following classification of cancer of the cervix based upon the extent of the disease.

Group I. Lesions limited to the cervix, no paracervical or parametrial fixation. Free mobility of the uterus.

Group II. Invasion of vaginal wall, slight paracervical and parametrial involvement. Some mobility of uterus.

Group III. Extensive paracervical and parametrial involvement with complete fixation of uterus.

Group IV. Direct invasion of surrounding viscera or distant metastases.

Under conditions which permit correct radiotherapy, hysterectomy has been largely given up in the treatment of carcinoma of the cervix. It is important to emphasize, however, that the correct use of radiotherapy in carcinoma of the cervix presupposes a thorough understanding of the principles underlying the method and a complete knowledge of the technique. The success of treatment depends upon the stage of the disease and upon the accuracy and precision of the technique.

In the treatment of very early lesions (group I) the intra-uterine and vaginal radiation need not

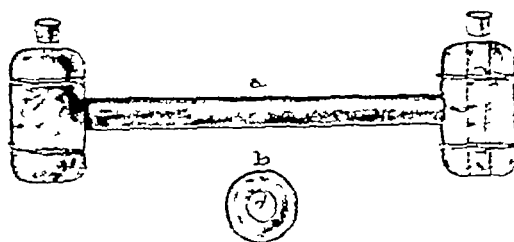


Fig. 2. Diagram of Curie colpostat. Each cork contains 10 milligrams of radium element. The filtration is 1.5 millimeters of platinum.

be supplemented by external radiation. In the treatment of the more advanced stages (grades II and III) the intra-uterine and vaginal radiations must be supplemented by external radiation. In the more advanced stages of the disease (groups III and IV), external radiation alone or combined with vaginal radiation are employed and intra-uterine radiation is omitted or deferred. Striking and sometimes unexpected prolonged palliative results may occur following irradiation of advanced carcinoma of the cervix. In isolated and rare examples, control of the disease over a 5 year period may be effected in advanced lesions which prove to be highly radiosensitive. The therapeutic test is the only certain method of determining this state. When the therapeutic test indicates that the lesion is radioresistant, it is best to proceed slowly with small doses in an attempt to effect palliative relief. Radical radiotherapy under these conditions is contraindicated.

TECHNIQUE OF IRRADIATION

Before treatment is begun, it is important to eliminate any local infection that may be present. When this precaution is observed, the incidence of a complicating pyrexia is reduced. When high fever develops during irradiation, the treatment must be temporarily discontinued and resumed only after the temperature has been reduced to normal. When the secondary infection is very pronounced it is best to begin treatment by external radiation of the cervical lesion through four pelvic fields. This procedure often results in diminution of the local infection and partial healing of the ulcerated surface.

Since it is impossible to determine with certainty the exact extent of the disease by clinical examination, the safest course to pursue in the radiation treatment of carcinoma of the cervix is to regard the entire cervix, paracervical tissues, and parametrium as potentially malignant and treat all lesions with maximum doses of radiation.

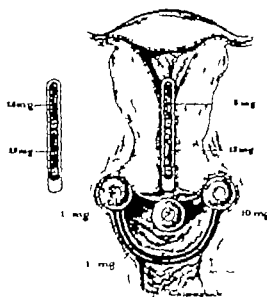


Fig. The distribution of radium in the treatment of cancer of the cervix with 60 milligrams of radium equally divided between the pterine canal and vagina. In order to administer 8,000 milligram hours the radium is inserted for 33-5 hours. In the lowest the terine applicator contains 50 milligrams and when this is used and the colpostat contains 50 milligrams the cancer of the cervix is treated with 80 milligrams of radium. When the dose employed is 8,000 milligram hours, the terine applicator remains in place 80 hours and the colpostat 133 hours.

That the use of small quantities of radium over a longer period is at least as efficacious as the use of large amounts during a short period, is incontestable. The weight of evidence favors the technique of prolonged irradiation as the more effective.

THE DIAGNOSIS OF CARCINOMA OF THE CERVIX

The clinical diagnosis of advanced carcinoma of the cervix presents no difficulties. The diagnosis of early carcinoma of the cervix depends upon microscopic examination of the suspected lesion. Because of the fact that early carcinoma of the cervix is a microscopic disease, the precise technique of performing the biopsy is important. In order to detect the presence of early carcinoma of the cervix with reasonable certainty the area from which the tissue is to be taken must be selected with the greatest care. A block of tissue about 4 millimeters wide, 15 millimeters long, and 1 centimeter deep is taken at right angles to the rim of the cervix. The use of endothermy is recommended as the most satisfactory method of excising the specimen for microscopic examination.

The defect is closed by a suture and paraffin sections of the biopsy are examined microscopically.

The usual method of performing a biopsy upon an ulcerated lesion of the cervix with a "punch" instrument is satisfactory only when the lesion is moderately advanced. In attempting to establish a diagnosis of early carcinoma of the cervix, this technique is entirely inadequate as the deeper part of the lesion may be missed and a negative specimen obtained when early carcinoma actually exists. A similar condition often obtains when a wedge-shaped specimen is removed by means of the scalpel. The sharp edge of the wedge, perhaps only 1 millimeter wide, frequently fails to demonstrate the presence of a minute focus of carcinoma. It is most important that the deep portion of the specimen which is the crucial part, be at least as wide as the outer part. Because of these considerations a rectangular endothermy wire constitutes an ideal method of removing a specimen from the suspected area. The rectangular endothermy wire is 15 millimeters long and 4 millimeters wide, and was designed to remove a block of tissue of these dimensions and of any desired depth. The biopsy specimen obtained by this method consists of a block of tissue about 15 millimeters by 4 millimeters. The depth measurement should be approximately 10 millimeters. A rectangular block of tissues about 15 millimeters by 10 millimeters by 4 millimeters constitutes a satisfactory specimen for microscopical study.

HISTOLOGICAL VARIETIES

About 97 per cent of carcinomas of the cervix are of epidermoid origin and only 3 per cent are adenocarcinomas. The epidermoid carcinomas may be divided into squamous and non-squamous types. The non-squamous type has been termed by various authors as "plexiform" or "transitional." A third group comprising the most malignant form has been classified as "amplastic" by some writers. The following table indicates the histological varieties of cancer of the cervix.

	Squamous
	Plexiform (Ewing)
	Transitional (Lacazez, Martzloff)
Epidermoid carcinoma (97 per cent)	Amplastic (Beahy and Cutler)
	Spindle cell (Martzloff)
	Grades 3 and 4 (Broders)
Adenocarcinoma (3 per cent)	

Adenocarcinomata of the cervix are radioresistant and do not respond well to radiation therapy. The epidermoid carcinomata constitute the radiosensitive group, but within this group there exists a pronounced variation in radiosensitivity. The squamous types with marked differentiation, pronounced squamous features, hornification and keratinization are more resistant than the more undifferentiated anaplastic types. The radiotherapeutic procedure is influenced by the histological structure only to the extent of differentiating between the epidermoid and glandular carcinomata.

Adenocarcinoma of the fundus uteri may grow downward, and by presenting at the external cervical canal give rise to the clinical diagnosis of carcinoma of the cervix. Microscopical examination of a biopsy establishes the true origin of the lesion and guides the therapeutic procedure. In extremely early carcinoma of the cervix in which an extensive hysterectomy is sometimes considered, if the histological structure shows a high grade of malignancy (anaplastic type or grade 4 type) the surgical procedure is absolutely contraindicated. With these isolated exceptions the histological structure should not influence the character or extent of the radiotherapeutic procedure.

CLINICAL VARIETIES

The Cancer Committee of the League of Nations (1929) has proposed the following classification of cancer of the cervix based upon the extent of the disease.

Group I Lesions limited to the cervix, no paracervical or parametrial fixation. Free mobility of the uterus.

Group II Invasion of vaginal wall, slight paracervical and parametrial involvement. Some mobility of uterus.

Group III Extensive paracervical and parametrial involvement with complete fixation of uterus.

Group IV Direct invasion of surrounding viscera or distant metastases.

Under conditions which permit correct radiotherapy, hysterectomy has been largely given up in the treatment of carcinoma of the cervix. It is important to emphasize, however, that the correct use of radiotherapy in carcinoma of the cervix presupposes a thorough understanding of the principles underlying the method and a complete knowledge of the technique. The success of treatment depends upon the stage of the disease and upon the accuracy and precision of the technique.

In the treatment of very early lesions (group I) the intra-uterine and vaginal radiation need not

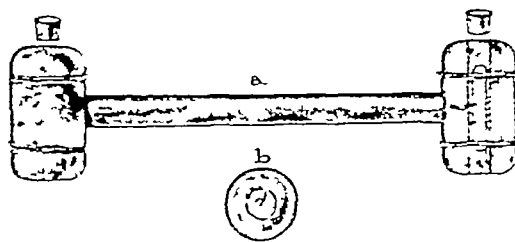


Fig 2 Diagram of Cune colpostat. Each cork contains 10 milligrams of radium element. The filtration is 1.5 millimeters of platinum.

be supplemented by external radiation. In the treatment of the more advanced stages (grades II and III) the intra-uterine and vaginal radiations must be supplemented by external radiation. In the more advanced stages of the disease (groups III and IV), external radiation alone or combined with vaginal radiation are employed and intra-uterine radiation is omitted or deferred. Striking and sometimes unexpected prolonged palliative results may occur following irradiation of advanced carcinoma of the cervix. In isolated and rare examples, control of the disease over a 5 year period may be effected in advanced lesions which prove to be highly radiosensitive. The therapeutic test is the only certain method of determining this state. When the therapeutic test indicates that the lesion is radioresistant, it is best to proceed slowly with small doses in an attempt to effect palliative relief. Radical radiotherapy under these conditions is contra-indicated.

TECHNIQUE OF IRRADIATION

Before treatment is begun, it is important to eliminate any local infection that may be present. When this precaution is observed, the incidence of a complicating pyrexia is reduced. When high fever develops during irradiation, the treatment must be temporarily discontinued and resumed only after the temperature has been reduced to normal. When the secondary infection is very pronounced it is best to begin treatment by external radiation of the cervical lesion through four pelvic fields. This procedure often results in diminution of the local infection and partial healing of the ulcerated surface.

Since it is impossible to determine with certainty the exact extent of the disease by clinical examination, the safest course to pursue in the radiation treatment of carcinoma of the cervix is to regard the entire cervix, paracervical tissues, and parametrium as potentially malignant and treat all lesions with maximum doses of radiation.

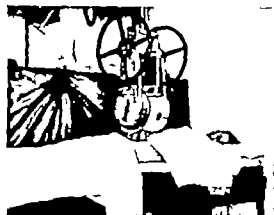


Fig. 3. Photograph of a gram radium pack used in the treatment of the parametrium in carcinoma of the cervix. (This technique is employed in a group of cases in an effort to develop a more effective irradiation of the parametria.)

Anesthesia A decision upon the method of anesthesia must be made in each individual case. In most instances the entire procedure can be carried out under morphine and without the use of a general anesthetic. A combination of morphine, grains $1/6$, and scopolamine grains $1/200$, administered $1\frac{1}{2}$ hours before treatment and repeated 30 minutes before treatment is applicable in many cases and is highly satisfactory. In very nervous patients a general anesthetic may be advisable, especially when there is some difficulty in locating the external cervical canal.

Dilatation of the cervical canal and insertion of radium. The usual pre-operative procedures are carried out. The vulva is shaved and the vaginal cavity is irrigated with a mild antiseptic douche. The cervical canal is located and the length of the uterine canal is determined by means of a sound.

When the lesion is advanced and especially when it is situated at the external cervical orifice it may be exceedingly difficult or even impossible to locate the cervical canal, which sometimes becomes greatly distorted. Because of the friability of the tumor tissue, there is great danger of creating false passages with the uterine sound and perforating directly into the peritoneal cavity. I have performed several autopsies on patients in whom this accident has led to a fatal peritonitis. When this difficulty is encountered, the safest course to pursue after the most careful and gentle attempts to locate the external cervical orifice have failed, is to insert the colpostat only and proceed with combined vaginal and external radiation. Not infrequently the regression effected by

these procedures removes the difficulty of locating the cervical canal and permits the intra-uterine radium insertion.

The cervical canal is dilated gently with graduated Hegar dilators. When the dilatation is complete, the radium is inserted. No attempt is made to suture the applicator. The colpostat is next inserted by holding the applicator vertically and inserting first one cork and then the other. The colpostat is then rotated 90 degrees so that the two corks and the metal spring are in a horizontal plane (Fig. 4). The third cork is then inserted directly against the external cervical canal and the tip of the uterine radium applicator. When the vagina is small the insertion of the third cork may be impossible.

Having inserted the uterine applicator and the colpostat, the next step is to insert the vaginal packing. This procedure is of extreme importance and should be executed with the greatest care and precision. Its purpose is twofold: to pack away the bladder and rectum and to maintain position of radium applicators during irradiation.

Two inch gauze packing cut in short lengths and soaked in acriflavine is packed between the colpostat and the rectum, between the anterior lip of the cervix and the bladder and into the lateral vaginal fornices. Sufficient packing should be introduced to fill the vagina completely so as to permit no displacement of the radium applicators. The anterior and posterior vaginal retractor should be maintained in position during the entire procedure and gently removed after the packing is completed. A perineal pad is immediately applied and fixed firmly in position. Unless this precaution is taken the packing and radium may be dislodged when the patient vomits while awakening from the anesthetic.

The radiation is continued over a period of approximately 5 days. The vaginal radium is removed daily cleaned and reinserted. It is usually unnecessary to remove the uterine applicator daily unless there are special indications. The vagina is irrigated daily during this procedure. A total dose of 7,000 to 8,000 milligram hours is administered, equally divided between the cervical canal and the vagina.

In the following groups the use of external radiation as the initial procedure is preferable.

1. In advanced lesions that have distorted the cervical canal rendering it difficult and sometimes impossible to locate the external orifice.

2. In bulky papillary carcinomata which encroach upon and sometimes fill the vaginal cavity rendering it impossible to insert radium into the vagina.

3 In patients with advanced lesions, marked weakness and secondary anemia in whom external radiation causes cessation of bleeding and improvement in general health

Under these conditions the radium insertion is made 3 or 4 weeks after the external radiation when the general condition of the patient is sufficiently improved to permit this procedure

During the irradiation the patient remains in bed. It is usually necessary to catheterize the bladder at 8 hour intervals. The patient experiences nausea, and less frequently vomiting occurs. The commonest cause for interrupting the treatment is the development of high fever. When this occurs the radium is promptly removed.

Specifications of radium applicators The intra-uterine radium applicator used in the Tumor Clinic of Michael Reese Hospital consists of an aluminum shell 5.4 centimeters long and 0.65 millimeters in diameter (Fig. 5) containing two platinum capsules end to end. Each platinum capsule is 21 millimeters long, 0.35 millimeters in diameter, 1.0 millimeters wall thickness, and contains 25 milligrams of radium element. The applicator contains a total of 50 milligrams.

The smallest quantity of radium that is practical for intra-uterine radiation in carcinoma of the cervix is 30 milligrams. This amount can be utilized in several different forms as for example, two capsules each containing 15 milligrams. If the radium available happens to be in the form of 5 milligram needles, three needles can be grouped in each of two platinum capsules (1.0 millimeter wall thickness) and these can be placed end to end in an aluminum shell.

The Curie colpostat (Fig. 2) is composed of two corks mounted on a spring and a third cork that is loose for insertion directly against the external cervical canal. Each cork is constructed to hold a radium tube in its center. The vaginal irradiation is performed by inserting the colpostat into the vaginal fornices and against the cervical canal as shown in Figure 4. Each cork contains 10 milligrams of radium element so that the colpostat contains a total of 30 milligrams. Two methods of distributing radium foci in the uterine canal and vagina in the treatment of carcinoma of the cervix are shown in Figures 1 and the inset.

The quantity of radium necessary in the treatment of carcinoma of the cervix The amount of radium necessary for the efficient treatment of carcinoma of the cervix is about 60 milligrams. As much as 80 milligrams may be employed, but this amount should not be exceeded if it is desired to prolong the time of irradiation. The smallest quantity of radium that is practicable is 60 milligrams. With

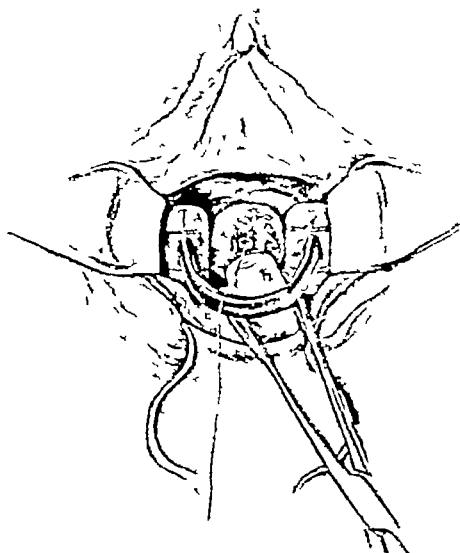


Fig. 4. Diagram showing technique of inserting the Curie colpostat in the treatment of carcinoma of the cervix.

this amount a dose of 8,000 milligram hours requires 133.3 hours (5 days and 13.3 hours) to administer.

Filtration The filtration of the cervical-uterine applicator should be 1.0 millimeter platinum and the filtration of the tubes in the colpostat at least 1.0 millimeter platinum (preferably 1.5 millimeters). The tissues are protected from secondary radiation by the aluminum shell or by the rubber when a rubber sound is used.

External radiation with radium pack In the Tumor Clinic of the Michael Reese Hospital intra-uterine radiation is promptly followed by external radiation by means of the 4 gram radium pack. This technique is being used in a series of cases in an effort to increase the efficiency of the irradiation of the parametrium. Seven portals of entry are utilized in the irradiation of the parametria: two anterior, two posterior, two lateral, and one perineal fields are treated. The distance is 10 centimeters, the portal 10 centimeters in diameter, the filtration equivalent to 1.5 millimeters platinum. Each field receives 30,000 milligram hours, the total dose is 210,000 milligram hours. The patient is treated for 2 hours daily over a period of about 26 days. There is usually little or no radiation sickness associated with this procedure. The patient begins to complain of nausea and anorexia during the latter part of the radiation cycle. There is some reduction in the red blood cells and white

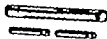


Fig. 5. Diagram showing aluminum shell containing two platinum capsules used for intra-uterine radiation. Each capsule contains 55 milligrams of radium element. This applicator is 5.4 centimeters long and 31 millimeters in diameter and contains 50 milligrams of radium.

blood cells, but this change is temporary and without special significance.

A 4 gram radium pack placed at a distance of 10 centimeters from the skin is also employed in the Curie Institute of Paris in the treatment of the parametria in carcinoma of the cervix. The results of this clinical investigation are not yet available consequently it is not possible at this time to state with certainty whether this form of therapy will yield a higher percentage of cures than the technique in which the intrauterine and vaginal radium applications are supplemented by high voltage X-ray therapy. One great advantage of the radium pack is that there is almost no radiation sickness.

External radiation with X-rays. External radiation with high voltage X-rays is usually administered through four portals of entry. The parametrium is thus irradiated through four pelvic fields. The entire cycle of irradiation is preferably administered within a period of 3 weeks. The technique employed is as follows: The voltage is 500 000 kilovolts filtration $\frac{1}{4}$ to $\frac{1}{8}$ millimeters copper milliamperes 5 distance 50 centimeters, skin portals 14 centimeters by 14 centimeters up to 23 centimeters by 23 centimeters. Approximately 600 r units are delivered to each of 4 to 6 portals in divided doses, each exposure being about 150 r units. The entire cycle is usually given within 3 weeks.

COMPLICATIONS

The mortality from radiotherapy of cancer of the cervix is about 1 per cent and is due almost entirely to infection. When the temperature rises during irradiation the treatment must be promptly discontinued. An old adnexal infection may be lighted up by irradiation. Hemorrhage is an uncommon complication and irradiation need not be discontinued in its presence. Mild proctitis and cystitis are temporary and rarely severe.

Serious complications may arise from errors and imperfection in technique. Failure to keep radium applicators in their proper position may lead to rectovaginal or vesicovaginal fistula. These complications do not follow correct irradiation. In advanced lesions of the cervix, rectovaginal fistula may develop as a result of extension of the disease and not as a consequence of radiation.

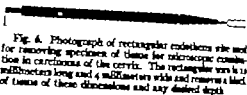


Fig. 6. Photograph of rectangular endometrium wire used for removing specimens of tissue for microscopic examination in carcinoma of the cervix. The rectangular wire is 10 millimeters long and 4 millimeters wide and removes a block of tissue of these dimensions and any desired depth.

RESULTS

The results of radium treatment of cancer of the cervix have shown a steady improvement during the last 15 years, as the technique of radiation has been perfected. Lacazeague compares the average 5 year cures between 1919 and 1924 as follows.

Per cent	Per cent	Per cent	Per cent
1919	10	1923	26
980	15	1924	30
91	7	1924	23

Lacazeague states that the present percentage of cures in carcinoma of the cervix in the Curie Institute is probably 75 per cent for group I, 50 per cent for group II, and 25 per cent for groups III and IV. Considering all four classes, the cures are about 40 per cent.

Healy quotes the following statistics in 1924 cases from the Memorial Hospital, New York.

	Cases	Five year cures
Early	97	53.0
Borderline	100	34.6
Advanced	187	15

Statistics from the Woman's Hospital (Ward) show 33.1 per cent 5 year cures in classes I, II, III and IV. In classes I and II the 5 year cures are 53.1 per cent. Heyman's report (1927) of cases treated in the Radiumhemmet shows 33.4 per cent cures in all classes and 44.4 per cent cures in the operable group. A series of combined statistics published by Ward (1928) show the following comparison between surgical and radiological treatment.

	All stages	Operable stages	Primary mortality
Operative treatment	18	35.6	7.1
Radiological treatment	103	34.9	1

From a study of these results Ward concludes that irradiation of carcinoma of the cervix yields results at least as good as those obtained by radical operation with less primary mortality.

The results of radiotherapy of cancer of the cervix have improved steadily with improvement in the technique of radiation. The present effort to improve the results is in the direction of increasing the efficiency of irradiation of the parametrium. It is hoped that these investigations may lead to further increase in the percentage of cures.

FROM THE MEMORIAL HOSPITAL, NEW YORK

THE TECHNIQUE OF THE SUPRAPUBIC IMPLANTATION OF RADON SEEDS IN BLADDER CARCINOMA

B S BARRINGER, M D, F A C S, NEW YORK

THE technique of the suprapubic method of implantation of radon seeds into bladder tumors as developed at the Memorial Hospital is a comparatively simple procedure. It meets Keyes' dictum that a "malignant operation should not be performed for a malignant disease." It has a low operative mortality, between 3 and 4 per cent, yet succeeds in controlling many tumors that are quite inoperable. It is especially successful in dealing with tumors of the bladder base and trigone.

However, the implantation often is not properly performed. There are two principal reasons for this failure: first, the surgeon who is responsible for the diagnosis and the operation is usually not trained in radium therapy; second, an adequate number of radon seeds of a proper strength is often not available. One should have at hand for this procedure half again as many radon seeds as one thinks are required, since no cystoscopy or cystogram can possibly indicate the extent of a large bladder tumor.

In developing the technique of the radium implantation we have gone through numerous phases. We began quite blindly with little or no knowledge of a proper radium dose or an adequate way to apply radium to the bladder cancer. We had to deal with a tumor of a thin walled internal organ, somewhat difficult to approach surgically. Any disturbance of its function might readily cause a corresponding disturbance of the vital kidney function. We have encountered numerous discouragements in developing our technique. Certain basic principles of treatment have been revealed. First, the value of any treatment must be judged clinically. Conclusions based upon experimental animal work, as to the area irradiated by any one dose of screened or unscreened radium has had to be corrected by accurate clinical observations. Second, one kind of therapy alone should be used, as confusion inevitably arises if two or more forms of therapy are combined, for instance fulguration and radium or partial resection and radium. Any one form of treatment has to be tested for years, before its ultimate value can be ascertained. Changes in type of therapy or in the method of applying any

one therapeutic agent should be reluctantly made and then only when the failure of the therapy under consideration is conclusively proved. Conversely it is futile to stick stubbornly to lost causes. In all of our 17 years of work we have consistently used radium alone to control bladder cancers.

Bladder tumors, as indeed, all malignant tumors, are best dealt with in institutions particularly devoted to this work. The entire treatment must be performed by one man, who is both surgeon and radiotherapist. In other words, a trained surgeon cannot open the bladder and then call in a man trained in radium therapy to finish the work. I think such a procedure very rarely results in anything but failure. These seem to be basic principles of the treatment of bladder carcinoma.

Turning specifically to the control of bladder carcinoma by radium, we have two methods of approach, radium applied through the cystoscope and radium applied through the open bladder. We have a comparatively large series representing the successful use of each of these methods, but experience has shown that the cystoscopic method should be used only for small tumors, whether infiltrating or papillary, and only if the tumor is easily reached. It should be used reluctantly and only when one is thoroughly experienced in this method.

The suprapubic method of approach is the one of choice. There are points in favor of always using it: first, the ease with which it can be done; second, its relatively low mortality.

In the first 109 consecutive personal cases treated suprapubically, 4 patients died in the hospital, an operative mortality of 3.6 per cent. Since that time my operative mortality has risen to about 4 per cent. This percentage of mortality is low when one considers that in this series many inoperable cases are included.

SPINAL ANÆSTHESIA

For the past 6 years we have used spinal anæsthesia. During this time we have resorted to general anæsthesia very rarely, perhaps in not more than 5 per cent of the cases. The anæsthetic

SURGERY GYNECOLOGY AND OBSTETRICS

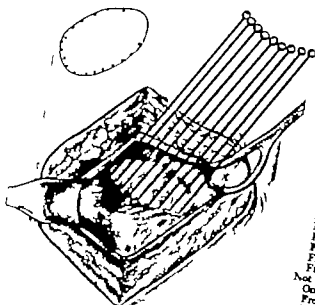


Fig. 1. The bladder is open. The loop retractor in place. The radium bearing needles covering one side of the tumor. The next line of needles is placed just above the first line.

that we have used has been novocain, a preparation in glass ampuls of novocain, a cubic centimeters of a 5 per cent solution. The anesthesia usually has been given through the fourth lumbar inter space. Occasionally we have had to supplement spinal anesthesia with infiltration anesthesia of the skin and abdominal muscles, their nerves coming from a higher level than those of the bladder. This is particularly so when the operation is started immediately after the spinal anesthesia is given. In all of our spinal anesthetics, now over 1,000 cases, we have never had a death from the anesthesia. The patient's shock has been minimized. The patients are able to take fluids in much larger quantities and sooner than after a general anesthetic.

The main object of the suprapubic operation is a good exposure of the tumor. I have tried the Pfannenstiel incision in a series of cases, but do not like it as well as the mid-abdominal. If the wound of a Pfannenstiel incision becomes infected, as it occasionally does, because of the fact that a good many bladder tumors are infected, more chance of hernia after an infected Pfannenstiel incision than after an infected midline incision. The midline incision should be sufficiently

TABLE I.—NINETY EIGHT CASES OF CANCER OF THE BLADDER DIAGNOSED ON PATHOLOGICAL OBSERVATIONS

Cases	Radonium with typical cells or papillary outgrowths		Submucous	
	Number	Per cent	Number	Per cent
Controlled	51		47	
Controlled over 3 years	27	52.9	29	61.7
One year	2	4.0	14	29.7
From 1 to 2 years				
From 2 to 3 years				
From 3 to 4 years				
From 4 to 5 years	3		3	
From 5 to 6 years	3		3	
From 6 to 7 years	0		0	
From 7 to 8 years	1		1	
From 8 to 9 years	3		3	
From 9 to 10 years	3		3	
From 10 to 11 years	3		3	
From 11 to 12 years	1		1	
From 12 to 14 years	0		0	
Not controlled	0		0	
One year	24	47	5	9.9
From 1 to 2 years	11		1	
From 2 to 3 years	9		7	
From 3 to 4 years			1	
From 4 to 5 years			1	
From 5 to 6 years	1		1	
From 6 to 7 years			1	
From 7 to 8 years			1	
From 8 to 9 years			1	

large. Self-retaining retractors should be placed in the wound to hold the muscles apart. The most useful bladder retractors in my hands are those which we devised at the Memorial Hospital some years ago and called the Memorial Hospital some years ago and called the loop wire retractor. The wound should be adequately screened with gauze before the bladder is opened. The bladder contents should be removed by suction apparatus, care being taken not to spill the bladder contents. The Cameron light should be used for illumination.

If the tumor is papillary the papillary portions are removed by some form of cautery so as to expose the tumor base. If the tumor is flat and the surface sloughy and ulcerated a light cautery should be done, in a measure to control the infection. The base of the tumor should now be implanted with radon seeds, of a strength between 1 and 1½ millicuries. If the tumor is in the bladder base where it is backed up by the prostate and periprostatic tissues, we can place the seeds deeper than if the tumor is on the lateral walls or apex of the bladder. If the seeds are low in value they should be placed considerably nearer together than 1 centimeter. If the tumor is deeply infiltrating considerable care must be used in deciding just how deeply into the infiltrating parts the radium bearing needles may be placed. To treat a large tumor accurately we

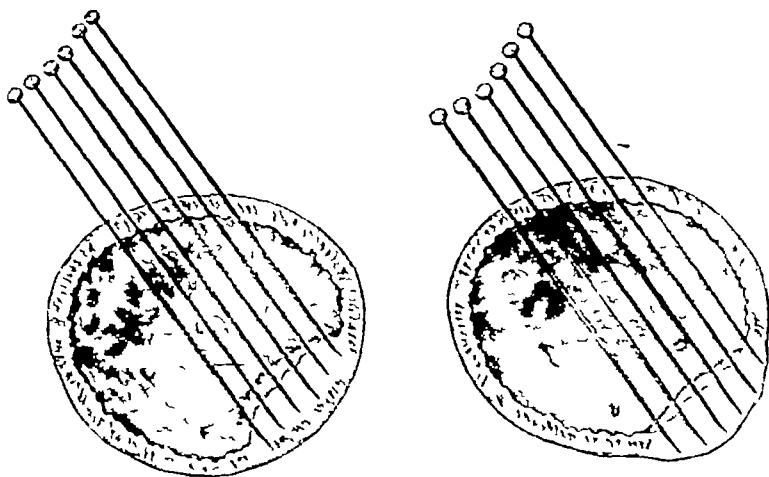


Fig. 2 Showing how the radium bearing needles are inserted deeply into the tumor. Judgment as to how far to go is important to obtain the proper radiation.

should have at least twenty radium bearing needles. A line of these needles is placed on the extreme edge of the tumor, then a second line above this, the first needles not being removed until the second line is completed. Continuing in this way we can cover the field very accurately. A suprapubic drainage tube is left for a few days to a week or two, according to the reaction caused by operation, infection of the bladder, and bleeding. The bladder is not sutured to the fascia.

The patient does not have any radium reaction until 10 days or 2 weeks have elapsed, and the height of the radium reaction occurs perhaps a month after implantation and then slowly recedes. Pain and urinary frequency are caused by this reaction. The larger the radium dose and the nearer the tumor to the bladder neck, the greater the reaction. All in all there is a great deal less reaction from the gold seeds than from the glass seeds which we used some years ago. The elimination of most of the β rays is responsible.

If the dose of radium is large and placed in the portion of the bladder adjacent to the rectum, there may be for several days to a week some rectal irritation. This is not serious and can always be controlled.

COMPLICATIONS OF RADIUM TREATMENT

1 *Kidney complications.* In making the implantation we do not pay any attention to the

urethral orifices even if the tumor is directly over one or both. There have been 2 cases of acute infection of the kidney subsequent to the operation in which we have had to drain the kidney. There have been a few cases of subsequent destruction of the kidney probably from absorption by way of the lymphatics of the ureter to the kidney. The cases have been fewer, I believe, than happens when the ureter is cut off surgically and reimplanted in the bladder. We are at the present time looking over our statistics with the object of making a report on this condition.

In a number of cases stone and gravel have formed on the slough of the tumor, necessitating in two instances the opening up of the bladder and the removal of the stone.

2 *Rupture of the bladder.* We have had 2 cases of rupture of the bladder, one about 12 years ago and the other recently, in which the bladder ruptured after radium implantation. The latter was a complicated case of intestinal tumor involving the bladder. The tumor was removed by another surgeon, recurred, and was implanted with radium. The patient died 6 months later of an infection following bladder rupture. No carcinoma was present at the time of the patient's death.

We have had 1 case of vesicorectal fistula which lasted for a long period of time and then healing took place.

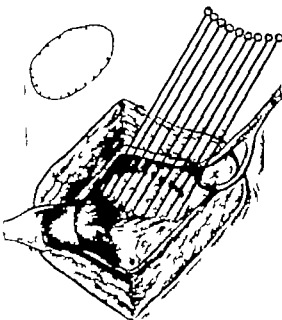


Fig. 1. The bladder is open. The loop retractor in place. The radium bearing needles covering one side of the tumor. The next line of needles is placed just above the first line.

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The main object of the suprapubic operation is a good exposure of the tumor. I have tried the Pfannenstiel incision in a series of cases, but do not like it as well as the mid-abdominal. If the wound of a Pfannenstiel incision becomes infected, as it occasionally does, because of the fact that a good many bladder tumors are infected, we get into trouble. I believe that there is much more chance of hernia after an infected Pfannenstiel incision than after an infected midline incision. The midline incision should be sufficiently

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Cases	Papillom with atypical cells or papillary carcinoma		Infiltrating carcinoma	
	Number	Per cent	Number	Per cent
Controlled	51	52.0	47	48.0
Controlled over 3 years	2	4.0	14	29.8
One year	1		3	
From 1 to 2 years	1		1	
From 2 to 3 years	1		2	
From 3 to 4 years	3		2	
From 4 to 5 years	6		2	
From 5 to 6 years	1		1	
From 6 to 7 years	3		1	
From 7 to 8 years	3		3	
From 8 to 9 years	3		3	
From 9 to 10 years	0		1	
From 10 to 11 years	0		1	
From 11 to 12 years	0		1	
From 12 to 13 years	0		1	
From 13 to 14 years	0		1	
Not controlled	47	47.9	25	52.1
One year	0		7	
From 1 to 2 years	1		1	
From 2 to 3 years	1		1	
From 3 to 4 years	1		1	
From 4 to 5 years	1		1	
From 5 to 6 years	1		1	
From 6 to 7 years	1		1	
From 7 to 8 years	1		1	
From 8 to 9 years	0		1	

large. Self-retaining retractors should be placed in the wound to hold the muscles apart. The most useful bladder retractors in my hands are those which we devised at the Memorial Hospital some years ago and called the loop wire retractor. The wound should be adequately screened with gauze before the bladder is opened. The bladder contents should be removed by suction apparatus, care being taken not to spill the bladder contents. The Cameron light should be used for illumination.

If the tumor is papillary the papillary portions are removed by some form of cautery so as to expose the tumor base. If the tumor is flat and the surface sloughy and ulcerated, a light cauterization should be done in a measure, to control the infection. The base of the tumor should now be implanted with radon seeds, of a strength between 1 and 1½ millicuries. If the tumor is in the bladder base where it is backed up by the prostate and periprostatic tissues, we can place the seeds deeper than if the tumor is on the lateral walls or apex of the bladder. If the seeds are low in value they should be placed considerably nearer together than 1 centimeter. If the tumor is deeply infiltrating considerable care must be used in deciding just how deeply into the infiltrating parts the radium bearing needles may be placed. To treat a large tumor accurately we



Fig 1A



Fig 1B



Fig 2

Fig 1 A, Four minute picture Pregnancy, 2 months, pulmonary tuberculosis Showing beginning dilatation of both ureters B, Ten minute picture. Ureters more clearly shown, with dilatation and kinking more evident. No apparent displacement of either ureter

Fig 2 Twenty-minute picture Pregnancy, 2 months Previous right nephrectomy for tuberculosis Picture shows markedly dilated, linked, and tortuous left ureter, with marked dilatation of left kidney calyces The pregnant uterus is very well outlined

Fig 3 Five minute picture Pregnancy, 2 months, pulmonary tuberculosis Both ureters are clearly outlined and showing distinct dilatation

Fig 4 A, Five-minute picture Pregnancy, 4 months, manic depression psychosis Ureters show marked dilatation and kinking B Picture taken 3 weeks after removal of fetus by hysterotomy Shows continued dilatation and kinking of right ureter (retrograde pyelography) C, Picture taken 3 weeks after removal of fetus by hysterotomy Shows continued dilatation and kinking of left ureter (retrograde pyelography)



Fig. 3.



Fig 4A.

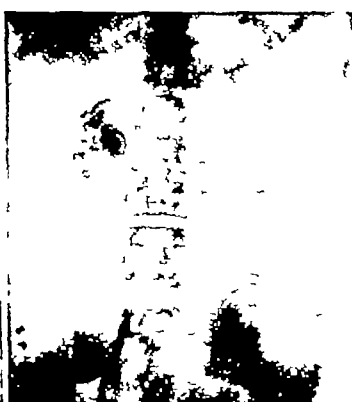


Fig 4B



Fig 4C

THE INFLUENCE OF GYNECOLOGICAL CONDITIONS ON THE GENITO-URINARY TRACT AS SHOWN BY SIMULTANEOUS INJECTIONS OF SKIODAN OR UROSELECTAN (INTRAVENOUSLY) AND LIPIDOL

A PRELIMINARY REPORT¹

ARTHUR STEIN M.D. F.A.C.S., New York

Associate Gynecologist, Lenox Hill Hospital

MORTIMER RODGERS M.D. New York

Assistant Assistant Gynecologist, Lenox Hill Hospital

THE X-ray examinations discussed were undertaken with the idea of demonstrating, if possible, a relationship between changes along the female urinary tract which are based upon pathological conditions, such as fibroid tumors or ovarian cysts arising in the female pelvis. We were also interested to note whether or not a physiological tumor such as a pregnancy would cause any change in the urological system.

To accomplish our purpose we decided upon simultaneous intravenous injections of skiodan and transuterine injections of lipidol. The question naturally arose as to why it should be necessary to use any other method when we had retrograde pyelography at our command. We were anxious, however, to show conditions as they might actually exist and we were afraid that retrograde pyelography might cause some mechanical dilatation of the ureters or kidney pelvis, and, of course, with the use of skiodan these objections would be eliminated.

As to skiodan the Council on Pharmacy and Chemistry of the American Medical Association reports: Skiodan is proposed as a therapeutically indifferent medium for roentgenography especially for visualization of the urinary tract either by intravenous injection or by direct injection into the renal pelvis through a ureteral catheter. It has also been administered rectally. It has been reported that skiodan exerts a diuretic action, most marked during the first half hour after intravenous injection. Excretion studies show that within a few minutes after intravenous injection the concentration of skiodan in the urine reaches a maximum of from 4 to 6 per cent (corresponding to from 2 to 3 per cent of iodine). Usually 75 per cent is eliminated in 3 hours, more than 90 per cent in 10 hours, and the remainder within about 24 hours.

Dosage. For intravenous urography skiodan is administered in sterile aqueous solution (from 20 to 40 grams in 100 cubic centimeters) the average dose for adults being about 2 grams for each 15

pounds of body weight for retrograde pyelography an aqueous solution of skiodan (from 10 to 20 grams in 100 cubic centimeters) is injected through a ureteral catheter into the renal pelvis. Aqueous solutions of skiodan should be kept protected from light they can be kept for a considerable time without impairment but should be sterilized before use.

On the day before the intravenous injection of skiodan, the patient is given a soft diet, with a cleansing enema in the evening. During the night the fluid intake is restricted as much as possible.

As to lipidol, the use of iodized oils for transuterine injections has become common practice and it is, therefore, not necessary to discuss it here.

Our method of taking pictures is as follows: With the patient in the lithotomy position on a cystoscopy table, the cervix is exposed and all preparation for an immediate lipidol injection is made. A sterile aqueous solution containing 20 grams of skiodan is now injected into the median basilic vein of the arm, and immediately following this, the intrauterine lipidol injection is started. As soon as the latter is completed the first X-ray plate is taken, and with the intra-uterine cannula still in place because we desire to obtain stereoscopic pictures of the uterus and tubes, the second picture is taken a minute later. The uterine cannula is now withdrawn and the third and fourth plates are made at intervals of 5 and 10 minutes, respectively from the time of the completion of the intravenous skiodan injection. None of our patients showed any untoward symptoms following this double injection. Even in those cases in which a pregnancy existed, whether the stage of gestation was as early as 6 weeks or as late as 6 months, there were no uterine contractions noted and no attempt upon the part of the uterus to expel the fetus. As all our cases of pregnancy had been admitted to the hospital for a therapeutic interruption, we did not hesitate to inject the uterus with lipidol. How-



Fig 8



Fig 9



Fig 10

Fig 8 Ten minute picture. Extramural fibroma about 3 inches in diameter upper right portion of fundus. The kidneys are apparently normal, as is the left ureter but on the right side there is a moderate dilatation and tortuosity. It is possible that the fibroid, which was not demonstrable with the X ray, caused this dilatation and tortuosity.

Fig 9 Six-minute picture. Intramural fibroid about 4

inches in diameter impacted in pelvis. Both kidney pelves and ureters are plainly outlined. The left ureter seems to have been displaced laterally by the fibroid, but there is no evidence of dilatation of either ureter.

Fig 10 Ten minute picture. Pseudomucinous ovarian cyst the size of a large grapefruit. The renal pelves and ureters are well outlined. There is a slight displacement of the latter but no evidence of dilatation.

of gestation. On the other hand, with uterine myomata of a corresponding size no similar dilatation of either the kidney pelves or ureters was found. We were forced, therefore, to come to the conclusion that the dilatation of the ureters in pregnancy was a purely physiological process, while a pelvic tumor of a corresponding size, whether a fibroid or a cyst, was incapable of producing, by mechanical means alone a similar condition. We have had one case of prolapse of

the vagina but there was no effect demonstrable of this prolapse on either the ureters or kidneys.

The influence of carcinoma of the cervix or fundus will be studied as soon as suitable cases present themselves.

As this is only a preliminary report it has been our aim to show just a few interesting findings.

We should like to express our thanks to Dr Stewart, of the X-ray department of the Lenox Hill Hospital, for his co-operation and that of the department.



Fig. 5.



Fig. 6A.



Fig. 6B.



Fig. 7A.



Fig. 7B.

Fig. 5. Pregnancy 6 months. No Epiadol injected. Both kidney pelvis and ureters are distinctly outlined, the latter showing still more marked dilatation than was observed in the earlier pregnancy cases.

Fig. 6. A. Three-minute picture. Myoma size of 4 months pregnancy. The kidney pelvis are clearly defined and do not show any abnormal changes. Neither ureter is clearly defined. B. Five-minute roentgenogram. The

ureters on both sides have now become clearly outlined.

Fig. 7. A. Five-minute picture. Fibroids tot. Uterus size 6 weeks' pregnancy. There is practically no outline of the kidneys or ureters. B. Ten-minute picture. Fair outline of kidneys, pelvis, and ureters. Shows rotation of right kidney with clubbing of calyces. The left kidney appears more normal but is at a lower level than the right, which is the reverse of normal.

ever, despite these findings we should still naturally abstain from any such procedure in cases in which the pregnancy was expected to continue.

The cases so far examined can be classified under 2 groups: namely, those of pregnancy and those of pathological pelvic tumors. In the case of the latter the diagnosis was in every instance confirmed at operation.

In all, 11 cases were injected by this method, 5 of them being cases of pregnancy in which the

period of gestation varied from 6 weeks to 6 months. The best pictures were obtained at the end of five minutes but if there was any evidence of obstruction the outlines of the kidney pelvis and ureters remained distinct over a longer period, the length of which depended upon the type and extent of the obstruction present. A glance at the plates will show that in all pregnancy cases, even as early as 6 weeks, there is a dilatation of both ureters, this dilatation increasing with the period



Fig 2 A



Fig 2 B

Fig 2 Ulcerative tuberculous lesions of the ileocecal coil and terminal ileum. A, Multiple local areas of inflammation in ileum and Meckel's diverticulum. B, Marked ulcerative process above the ileocecal valve and multiple ulcers in the ileum.

exist, and in which children are not fed cows' milk. In Turkey, for example, it is exceptional that the infant is not nursed either by the mother or a wet-nurse, and yet, tuberculosis is prevalent in all forms and at all ages. Calmette conceded, however, that in different countries of Europe, as well as in the United States and Canada, bovine tuberculosis represents a factor in the infection of the human race of such magnitude as to render its eradication imperative.

Brown and Sampson incline to the view that the bacillus of bovine tuberculosis causes intestinal lesions less frequently than the human type of organism. They do not believe that this is necessarily dependent on any fundamental difference in the two bacilli, but rather on different pathological reactions of the respective hosts. In spite of the conflicting views on the subject, it would seem that the bovine type of organism is more frequently the cause of primary intestinal lesions than is the human type.

INCIDENCE

Data relative to the incidence of hyperplastic tuberculosis of the intestine are conflicting. In general, it may be said that foreign literature shows the condition to be more frequently recognized abroad, both clinically and pathologically, than in this country.

Herrick stated that in 800 consecutive post-mortem examinations at the Lakeside Hospital, hyperplastic tuberculosis of the intestine was not encountered. Hemmeter found only one such case in a series of 56 necropsies on subjects

affected with advanced pulmonary tuberculosis. However, he was cognizant of the fact that such lesions are not prone to occur if disease of the lungs is advanced. It is a striking fact that the incidence of hyperplastic tuberculosis is highest early in middle age. In a series of cases reviewed by Herrick, the greatest incidence occurred in the decade from 20 to 30 years. Our data corroborate Herrick's except that we noted fewer cases in the earlier age groups. The ages in our cases were as

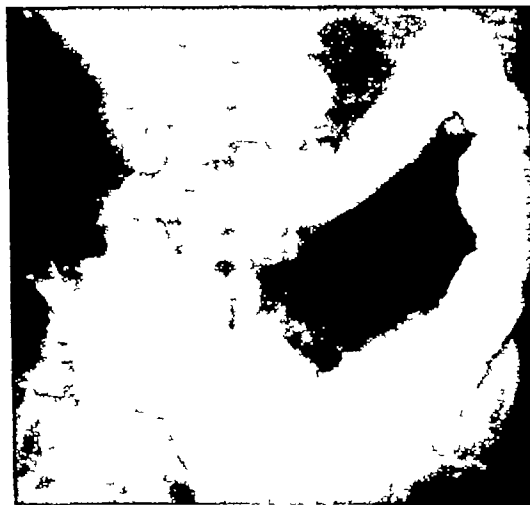


Fig 3 Characteristic filling defect produced by ulcerative tuberculosis of the ascending colon, cæcum, and terminal ileum.

SURGICAL TREATMENT OF TUBERCULOSIS OF THE LARGE BOWEL

FRED W. RANKIN, M.D., F.A.C.S., ROCHESTER, MINNESOTA

Division of Surgery, The Mayo Clinic

E. G. MAJOR, M.D., ROCHESTER, MINNESOTA

Fellow in Surgery, The Mayo Foundation

THAT certain localized forms of intestinal tuberculosis are particularly amenable to surgical extirpation is no longer controversial. Two types of tuberculous lesions occur in the large and small bowels: the first type and the one most satisfactorily treated surgically is hyperplastic tuberculosis, or so called tuberciform, and the second is tuberculous ulcerative colitis. The latter condition is frequently widespread and so many segments of the small bowel are affected that surgical intervention is less visible or impossible. It is also often associated with tuberculosis of other portions of the body for example the lungs. Hyperplastic tuberculosis, generally seen in the cecum and frequently involving the terminal ileum as well is quite successfully removed both from the standpoint of immediate mortality and subsequent successful outcome.

This report is based on a series of 65 cases observed in The Mayo Clinic in which complete data are available and in which short-circuiting operations or resection of the bowel or both had been performed.

The reluctance of surgeons to attack tuberculous lesions of the intestine is evidenced by a perusal of the literature bearing on the subject. The history of intestinal tuberculosis arises with that of pulmonary tuberculosis. Concomitant

diarrhea was noted by the Hippocratic school centuries ago, although the intestinal symptoms associated with pulmonary tuberculosis were not attributed to similar involvement of the bowel. Early literature dealing with intestinal tuberculosis was reviewed by Brunner in 1907. Brown and Sampson credit Mahabane with having performed the first short-circuiting operation for such a lesion. In 1869, Duguet described a case in which tuberculous tumor of the cecum, which presumably represented the hypertrophic form of the disease was found at necropsy. In 1891, Cornth reviewed in detail 85 of the early cases in which surgical procedures were undertaken for tuberculous lesions of the intestine, many of which were hypertrophied. He reviewed unpublished data concerning a patient operated on by Gussenbauer in 1832 in which the cecum and terminal portion of the ileum were resected because of such a lesion. Pioneers in this field of surgery were Czerny, Suchier, Billroth, Bouilly, Durantis, Fink, Roux, Holzmöhl, Obalinski, Beck, Frank, Sachs, and others, all of whom performed resection of the intestine because of tuberculous lesions of the bowel.

The results of contemporary surgeons in this field have been well reviewed in the writings of Brown and Sampson and need not be repeated here. Nevertheless, Archibald deserves a special word of commendation for the work he has done to put the treatment of this disease on a sound surgical basis.

BACTERIOLOGY

The type of bacillus responsible for the lesions of intestinal tuberculosis opens up a field of active discussion. Since Smith described the bovine type of organism in 1898, many investigators have held this virus to be the etiological factor in such lesions. Park and Krumweide, in a study of tuberculosis of the abdomen, found that the bacillus of bovine tuberculosis was responsible for the process in 50 per cent of patients aged less than 5 years, in 46 per cent of patients between 5 and 16 years, and in 23 per cent of adults.

Cafette, on the other hand, maintained that tuberculous infection of the intestines is common in countries in which bovine tuberculosis does not

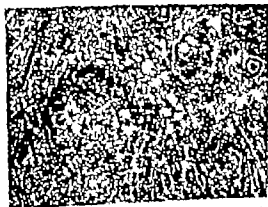


Fig. Tuberculosis of the cecum. Characteristic tubercles may be noted. (X13)

SYMPTOMS

Recognition of the hyperplastic form of intestinal tuberculosis in its early stages is difficult, because of the bizarre nature of the symptoms. The extreme chronicity of the disease, without sufficient incapacitation to demand early relief, is characteristic. The average duration of symptoms in our series of cases was slightly more than 4 years, which is significantly longer than if a malignant lesion is present in the same region. The disease usually presents itself as (1) a chronic condition which appears either as a progressive syndrome of dyspepsia, which is often labeled chronic appendicitis or chronic cholecystitis, or as a condition mimicking carcinoma, and (2) as definite symptoms of acute intestinal obstruction.

Pain and loss of weight are the most constant complaints. Pain was present in 91 per cent of our cases and was the presenting complaint in 74 per cent. The nature of the pain is variable, ranging from slight discomfort to the intense pain associated with intestinal obstruction. In many cases it is sharp, intermittent, and colic-like, usually accompanied by dull residual discomfort.

Abdominal distress is usually most pronounced following meals and often is relieved by vomiting, or even by movement of the bowels. At the onset there may be generalized abdominal discomfort, later localizing over the abdominal area to which pain from the involved segment of bowel is referred. More frequently the pain is sharply localized from the onset. Pain in the epigastrium or in the right upper quadrant is rare if lesions are of the ileocaecal coil of intestine, but in such cases there usually is evidence of intestinal obstruction. The pain may at first be transient, later it becomes more persistent, recurring from day to day, and finally is almost constant. In our series severe lancinating distress was present at some time during the course of the disease in 55 per cent of the cases. In a smaller percentage it was the presenting symptom.

Many clinicians believe that the pain associated with this condition is due to the involvement of the peritoneum. Nevertheless, the severe pain experienced by these patients is similar in some degree to that of partial intestinal obstruction, and may easily be occasioned by the abnormal motor activity of the intestine induced by the resistance offered to the onward movement of its content. Such obstruction may be due to spasm, stenosis of the intestinal lumen produced by stricture or proliferative reaction, localized peritonitis, or to adhesions between contiguous

loops of bowel. Thus, the greater frequency of pain after the ingestion of food is explained. The abdominal distress is usually intensified by pressure over the affected area, as well as by exercise. Flexion of the lower extremities often affords some relief.

Borock and Paschowa have postulated that involvement of the mesenteric glands may produce pain or tenderness at four points on the abdominal wall: (1) above the insertion of the mesentery, (2) below the insertion of the mesentery, (3) over McBurney's point, and (4) on the left side of the abdomen opposite the second lumbar vertebra.

Loss of weight is noticed almost as frequently as pain. It is usually progressive, but occasionally there may be a transient increase in weight during the course of the disease. The average weight lost in our series was 21 pounds, and in only 9 per cent of the cases was a history of loss not obtainable. The patient is usually in a marked state of emaciation when he presents himself for examination.

Diarrhoea occurs in many cases. It should be remembered that even in the hypertrophic form of the disease there is often some associated ulceration of the mucosa of the intestine. As a rule, the diarrhoea does not appear so early in the course of the disease as does pain. In 39 per cent of our series, diarrhoea was a prominent feature of the illness. In many cases the diarrhoea was periodic and often alternated with intervals in which the movements of the bowel were normal, or even constipated. Relationship of the diarrhoea to the site of the lesion is obscure, if any such relation exists. Constipation without alternating diarrhoea, is less commonly the only abnormality of intestinal movement noted by the patient. Such a condition was noted in 23 per cent of the cases. Borborygmus is a less common symptom, but does occur in many cases of partial or complete intestinal obstruction occasioned by the tuberculosis. It is not a common complaint in conditions in which the lumen of the bowel remains widely patent.

Intestinal hæmorrhage is rarely observed in cases of hyperplastic tuberculosis of the intestine, in only 1 case in our series was a hæmorrhage of any magnitude noted. The bacillus of tuberculosis may or may not be demonstrable in the stool. The temperature in these cases may be normal, elevated, or intermittent. It usually does not run a regular course from day to day. It may be normal for a few days with subsequent elevation, a course that is rarely seen in uncomplicated pulmonary tuberculosis.



Fig. 4. Hyperplastic tubercles of the caecum.

follows: 1 to 10 years, 1 case; 11 to 20 years, 1 case; 20 to 30 years, 23 cases; 30 to 40 years, 17 cases; 40 to 50 years, 13 cases; 50 to 60 years, 8 cases; and 60 to 70 years, 2 cases.

In a series of 34 cases of ileocecal tuberculosis,

Brown and Galters found that 10 patients only were aged more than 40 years; the average age in the group was 35 years. The average age in our series of cases also was 35 years.

It has been stated repeatedly that tuberculosis of the intestines is more prevalent among males than among females. In our series the proportion was 37 males to 28 females.

It is generally recognized that the ileocecal region is the site of election of the hyperplastic tuberculous lesion. We are not reporting here any primary lesions of the left side of the colon, although in one case, a tuberculoma occurred in the sigmoid loop 6 years after removal of a similar mass in the ileocecal region. Bergen, Copeland and Rankin have reported 2 cases of hyperplastic tuberculosis of the sigmoid, and Dowdle has reported 1 case. Bergen reviewed such a case in which the lesion was in the rectum. Nevertheless, lesions of the left side of the colon are extremely rare. The site of the lesion in our series was as follows: ileocecum, 50 cases, ascending colon, 8 cases; cecum and ascending colon, 3 cases; ileocecum and ascending colon, 2 cases; hepatic flexure, 1 case; transverse colon, 1 case.

It is obvious then that the incidence of hyperplastic tuberculosis is greater than has been generally recognized, that it is more prevalent among males than among females, and that the ileocecal region is the segment of intestine most frequently involved. Undoubtedly many such lesions have been erroneously diagnosed as actinomycosis, fibroma, sarcoma, and even carcinoma.



Fig. 5. Characteristic filling defect of hyperplastic tubercles of the caecum.

flammatory mural thickening, but the contours of the barium-filled canalized portion are smooth, the course of this portion is tortuous, and the mucosa is intact.

Of fundamental importance in the differentiation of the second group of diseases of the right side of the colon is the course of events in their pathological development, especially with reference to the site of the initial lesions and the progression of the disease. Chronic ulcerative colitis characteristically begins in the rectum and progresses proximally, amoebic ulcerative colitis and tuberculous ulcerative colitis, on the other hand, begin in the cæcum and progress distally. The presence of tuberculous colitis is postulated or ruled out by the condition in the thorax. The comparatively mild form of amoebic colitis seen in northern latitudes has a roentgenological appearance similar to that of chronic ulcerative colitis in that the affected portion of the colon is hyperirritable, the haustra are subdued, and signs of mucosal destruction are present, the colon preserves its pliability, thickening of the wall is not so severe, peristalsis is not interfered with so markedly, and the entire process does not give the impression of the severity observed in chronic ulcerative colitis. In the presence of active pulmonary tuberculosis with such roentgenological evidence in the colon, clinical and other laboratory data will be necessary to establish the diagnosis securely.

SURGICAL TREATMENT

Radical extirpation of the ileocæcal coil with end-to-side anastomosis between the terminal ileum and transverse colon in one or two stages is the procedure of choice for removal of the tuberculous focus. Whether it is done in one stage or in two stages depends entirely on conditions found at operation and the general resistance of the patient. We heartily concur with Turner that patients and pathological conditions cannot be standardized too closely, and certainly, with lesions of this character in this situation, individualization is extremely important. Beyond question, many of these operations can be done safely in one stage, the resection and anastomosis being supplemented by decompression with a Witzel enterostomy, but many of them, and particularly those of more advanced risk, are best done in two stages.

Ileocolostomy, or sidetracking of the intestinal content from the diseased area, may occasionally be demanded. That such an operation is sometimes advantageous is seen from the fact that there is occasionally subsequent recession of

symptoms, and in a few rare instances the mass seems to disappear entirely. Archibald found that by this maneuver pain was relieved in many cases but that the diarrhoea continued unabated, even being aggravated in some cases of intestinal tuberculosis by the ileocolostomy. If this operation is performed, medical measures should supplement it, as will be considered later.

Simple ileocolostomy or ileosigmoidostomy was done in 15 of our cases, and the follow-up record was available in 13. There was no immediate mortality, in spite of the fact that many of these patients were extremely poor operative risks. Six patients died in the year following operation, mostly from extensive pulmonary tuberculosis, but marked tuberculous enteritis was found at necropsy in 1 case. If the 1 case of this series in which coincident carcinoma of the stomach was present, for which surgical measures had been instituted, is deducted from the estimation of mortality, there still remains a death rate of 38 per cent in the first year.

Only 1 patient was well, symptomatically, after a significant length of time, which in this particular instance was 3 years. The 6 other patients showed varying degrees of improvement. One was entirely well except for a persistent fæcal fistula, another complained only of borborygmus, and the others had various complaints. In most cases, however, the presenting symptoms had been somewhat mitigated.

Resection of the involved loop of bowel, with ileocolostomy or ileosigmoidostomy, was done in 50 cases for hypertrophic tuberculous lesions. If the lesion is limited to the small intestine, the short-circuiting procedure indicated will, of course, be entero-enterostomy or ileocæcostomy, depending on the part of the small bowel which is involved.

Gratifying results are obtained from an analysis of the data in this series of cases. Four patients died in the first month after the operation. One of these patients died of tuberculous meningitis. If this case is deducted from the estimation of operative mortality, as may or may not be justified, the actual immediate mortality is 6 per cent. Five other patients died in the first year subsequent to operation, 4 of extensive extraintestinal tuberculosis, thus giving a total mortality rate of 18 per cent for the first year after operation. Four deaths (8 per cent of the cases) occurred in the second year, at least 1 of these deaths was attributable to extensive pulmonary tuberculosis. Another patient died 6 years after the primary operation of recurrence of the process in the intestine. In 12 of the cases the

A history of many indefinite vague, gastric complaints may be obtained, many of which the patients include under the term "dyspepsia" or "intestinal indigestion." These symptoms are usually slight and not localized and may persist unabated over long periods.

The accidental discovery of a mass by the patient, unaccompanied by general symptoms sufficiently severe to have demanded investigation, occurs in this type of case, just as it does in carcinoma. After the discovery of such a mass, however, the patients are usually able to recall slow and progressive indisposition which they may have attributed to various disorders. In the cases of our series in which the ileocecal region was involved, a tumor was usually palpable. The consistence of the mass was almost invariably described as doughy by the examining physician, in contrast to the induration of the carcinomatous masses in the same region. The tumor was often mobile, but much more frequently was bound down by a mass of adhesions so that it was more or less fixed to the surrounding tissues. A varying degree of tenderness usually accompanied palpation of the mass, although not of the severe grade present when the masses were acute and inflammatory.

The degree of anemia in cases of hyperplastic tuberculous lesions of the terminal part of the ileum and right half of the colon is not so marked as with carcinomatous involvement of the corresponding segment of bowel. The average percentage of haemoglobin in the cases of our series was 70 per cent, and the average number of erythrocytes in each cubic millimeter of blood of male patients, was 4,460,000 and of female patients 4,160,000. This stands out in strong contrast to the condition in cases of carcinoma of the right half of the colon, in which a severe grade of anemia is the general rule. The leucocyte count is not elevated unless a secondary infection is present. The average number of leucocytes for each cubic millimeter of blood was 8,900.

The condition of the thorax is of interest because of the controversy as to the possibility of the intestinal lesions being primary. Nevertheless, in a certain percentage of cases, there is no clinical evidence of a tuberculous focus elsewhere in the body and often an extra-intestinal focus cannot be demonstrated by the surgeon. In some cases quiescent tuberculous lesions of the lungs are present, in other cases the pulmonary tuberculosis is active, and in a few cases, cavitation is present. In this regard a sharp distinction must be made between the hyperplastic and the ulcerative types of intestinal tuberculosis, since

coexisting lesions of the thorax are common in the latter condition. In our series, the thorax was radiologically negative for tuberculosis in 56 per cent of the cases, and positive in 44 per cent. In 8 per cent of the entire series, cavitation was present.

ROENTGENOLOGIC DIAGNOSIS

The ulcerative type of tuberculous enterocolitis may be recognized roentgenologically by eliciting evidence of local or general hypermotility with filling defects, the method advocated by Brown and Sampson being used. This method may be practical when the group of cases known to have pulmonary tuberculosis is being dealt with exclusively. In general, however the study of anatomic changes, as revealed by the opaque enema and the combined double contrast method as advocated by Fischer and later by Gombos-Cohen, will be found to be more reliable and of greater differential diagnostic value. In the roentgenological laboratory of The Mayo Clinic, the use of any method is urged which will serve to elicit significant data, and in the diagnosis of intestinal tuberculosis the alimentary tract is studied from every possible angle.

In the differential diagnosis, tuberculosis of the colon must be distinguished from several diseases which affect the right side of the colon. One group of diseases which exhibit almost identical roentgenologic morphology is composed of tuberculous carcinoma, localized chronic ulcerative colitis, and the deformity produced secondary to pericecal abscesses, usually appendicitis. A second group includes tuberculosis, anorectic colitis and chronic ulcerative colitis. In the first group the filling defect is a special manifestation in the second extensive diffuse narrowing, loss of haustra, and mucosal destruction are characteristic.

Any type of ulceration of the colon, malignant or benign, may produce the Sclerlin sign. This phenomenon is not always pathognomonic for tuberculosis. Since primary tuberculosis of the colon is so exceedingly rare in the absence of active pulmonary tuberculosis, the roentgenological diagnosis of tuberculous colitis is based on the demonstration of a filling defect which usually extensively involves the cecum and ascending colon, or a markedly irregular and corrugated outline, and a peculiar boggy consistence of the bowel all in association with active pulmonary tuberculosis. Usually only a short segment of ascending colon is involved with the cecum in a pericecal inflammatory mass. The narrowing of the lumen may be great, due to the marked in-

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EXTERIORIZATION AND OBSTRUCTIVE RESECTION OF CARCINOMA OF THE SIGMOID¹

WILLIAM D HAGGARD, M.D., F.A.C.S., NASHVILLE, TENNESSEE

From the Surgical Division of Vanderbilt University

IN about half of the cases of cancer of the colon, the growth is located in the sigmoid, the same is true in regard to polyps of the colon. Though the growths are of adenomatous origin, this is suggestive of the local origin of cancer. What activates such local conditions into the unbridled cellular activity that produces the cancer entity?

Because the left half of the colon has but few lymphatic vessels, the prognosis for growths here is much better, from a surgical standpoint, than for growths located elsewhere. Cancer may be present for some time before dissemination occurs, so that if the diagnosis can be made sufficiently early, there is a better opportunity to secure a satisfactory result from operation. The end-results after operation in cancer of the colon

compare favorably with the results obtained in the treatment of cancer in any other site in the body, in fact, better results are obtained only in cancer of the lip. The average time the lesion is present before surgery is undertaken is almost a year.

Jones says it is not improbable that each year many patients with carcinoma of the colon are turned away from every large out patient department with the simple admonition to regulate the bowel whereas the patient should have been given an exhaustive examination to determine his real difficulty.

We shall have to divest our minds of the general belief that ordinary constipation is the explanation of changes in the patient's bowel habit. We must look upon recent constipation as of

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degree of improvement could not be definitely ascertained from the follow up letters, although these patients were still living. If these cases are deducted, data remain relative to the degree of improvement of 24 patients. One patient did not improve following operation. 2 noted moderate improvement but abdominal symptoms persisted, although much less severe than prior to resection. Two patients noted marked improvement after 2 and 4 years, respectively. Seventeen patients reported that they were entirely well subsequent to the resection, at varying periods following the operation: 1 patient at 3 months, 1 at 5 months, 1 at 6 months, 1 at 12 months, 1 at 15 months, 2 patients at 2 years, 2 at 3 years, 2 at 5 years, 1 patient at 7 years, 4 patients at 9 years, and 1 patient at 10 years. Two patients reported that they did not suffer from abdominal symptoms following operation, but 1 patient was in a sanitarium undergoing treatment for active pulmonary tuberculosis and the other had tuberculosis of the spine.

It must be borne in mind, in comparing the results of the simple operation of anastomosis with the results of operation in which resection was combined with short-circuiting, that the condition of the patients on whom the palliative operation was performed was necessarily worse than that of the others, otherwise resection would have been advocated in all cases.

It will be noted that the immediate mortality following resection of the intestine for hyperplastic tuberculosis is lower than that for carcinoma of the same region, although the operative procedures are identical, except that in the tuberculous cases the operation is usually done in one stage whereas in carcinomatous cases the operation in two stages is the procedure of choice. The greater resistance of the host, the milder degree of anemia, the lack of dehydration and of secondary infection account for the ratio in favor of tuberculosis. The mortality from resection in cases of hyperplastic tuberculosis will undoubtedly be decreased in the future by the more general adoption of the aseptic technique of intestinal resection.

COMPLICATIONS

The chief complication is the gradual onset of intestinal obstruction. Indeed, the history of severe, colic-like low or generalized abdominal pain, accompanied by vomiting, is frequently obtained when the patient is seen for the first time by the surgeon. So insidious is the onset of the disease that obstruction is usually not suspected until late.

Faecal fistula is not uncommonly associated with the condition. The usual history of appendectomy followed by persistent faecal fistula a few days after the operation is suggestive of tuberculous of the caecum. This complication, like obstruction, is to be met surgically with resection of the fistulous tract together with the diseased loop of bowel.

Perforation and intestinal hemorrhage are much more prone to occur with tuberculous enterocolitis than with hyperplastic tuberculous.

Since tuberculosis is essentially a medical disease, regardless of the site of the lesion, surgical measures should always be supplemented by careful medical supervision, both with the palliative and with the radical operation. The medical care in such cases is well outlined by Brown and Sampson.

CONCLUSION

It is undoubtedly true that hyperplastic tuberculosis is more common than is generally recognized, in spite of improved methods of differential diagnosis. The chief conditions to be distinguished from hyperplastic tuberculosis of the bowel are actinomycosis and malignancy. As a general rule, it may be said that hyperplastic tuberculosis tends to occur earlier than does carcinoma, but like all such rules, exceptions are relatively common. In view of the fact that surgical procedure should be instituted for both carcinoma and hyperplastic tuberculosis of the intestine, the differential diagnosis is not of so much import as might otherwise be the case.

There seems to be no question that radical resection of the tuberculous tumor is the operation of choice, provided the condition of the patient is adequate to meet the requirement for such a procedure. Otherwise a short-circuiting operation should be performed with subsequent resection of the mass. Usually however the one-stage operation is to be preferred.

SUMMARY

Sixty-five cases of hyperplastic tuberculosis of the intestine have been reviewed for which surgical measures were instituted. The symptoms of the condition have been considered briefly: pain and loss of weight are symptoms most frequently encountered. In 50 cases, the mass was resected, and in the 15 other cases a short-circuiting operation was performed. A study of the postoperative course of the two series of cases revealed that the results in the cases in which resection was done were definitely better than in those in which anastomosis alone was done.

times devoid of haustra and is smooth and pipe-like. Sometimes a redundant coil of distended sigmoid above is superimposed over the real growth. Manipulation under the fluoroscope will enable the roentgenologist to uncover the mass. If there is any doubt or uncertainty, a second examination is always wise.

We recently had a case of carcinoma of the rectosigmoid, in which the X-ray plates showed small diverticula in one portion and a definite obstruction lower down which we took to be a carcinoma. It might have been interpreted as a perforation of a diverticulum instead of a carcinoma. However, as Jones has shown, carcinoma very infrequently develops upon a diverticulitis. In the presence of diverticulitis with hemorrhage, operation must not be carried out because of the fear of cancer, for only in 1 to 8 per cent of the cases does cancer develop upon a pre-existing diverticulitis. As a matter of fact, according to Moore, diverticulitis is found in about 5 per cent of colons routinely examined with the X-ray.

The danger of complete obstruction from blocking by a hard mass of bismuth taken by mouth is generally appreciated. I think that the method of administering bismuth by mouth should be largely abandoned, for a barium enema is so much simpler, safer, and much more informative.

Obstruction occurs six and a half times as often on the left side as on the right side of the colon. If the obstruction is of the colon one may be sure that it is caused by cancer nine times out of ten. Petren, in Sweden, found that acute obstruction occurred in 42 per cent of 50 cases, Brown, of Edinburgh, found it in 25.7 per cent, Burgess, of Manchester, in 35.6 per cent.

Obstruction is the ultimate symptom in all cases of carcinoma of the colon. The obstruction is usually due to a secondary, inflammatory process causing additional swelling. The swelling and oedema which may be started by a purgative are the result of congestion and may cause complete obstruction. Recurring attacks of colic suddenly subsiding, indicating that partial obstruction has been temporarily relieved, are most significant. The stethoscope is useful in discerning a slight hissing and the metallic, tinkling sounds of the gas passing through a partial obstruction during peristalsis above the complete obstruction.

Perforation is more apt to occur in growths of the sigmoid than in growths in any other area in the colon.

If severe abdominal pain with nausea, vomiting, and obstipation persist after two turpentine enemas, obstruction may be said to be present.

Malignant obstruction is the most dangerous of all types of obstruction. The death rate after operation in such cases approximates 45 per cent.

When acute obstruction befalls the patient a "blind" cæcostomy without exploration, under local anaesthesia, is imperative. Manipulative examination literally squeezes highly virulent micro-organisms out of the oedematous growth, thus causing peritonitis. In the Brigham Hospital series taken as a whole the mortality following colostomies was nearly 40 per cent. The drainage opening, whether of the cæcum or colon, to be adequate and complete should preferably be of the exteriorized type than of the tube type. Very often the latter works poorly and the object of cleansing the colon, which is so essential prior to doing an aseptic resection with anastomosis, is frustrated.

Obstruction is not entirely an unmixed evil, for it has its good points, among which may be mentioned the fact that it compels an attempt at a life-saving operation. If the life-saving operation is successful a second operation may be done to remove the growth, so that there is secured the advantage of an enforced two stage operation—a matter of no small importance. Resection without a preliminary colostomy carries with it three times the danger encountered if preliminary colostomy is done (25.5 per cent versus 9.6 per cent). Grey Turner naively states that obstruction may be a fortuitous circumstance for a patient because it obliges one to do the operation in two stages. Well planned rehabilitation should be instituted with adequate decompression and cleansing of the intestinal tract, counteraction of dehydration, and semistarvation with high colonic, non-residue forming carbohydrates.

Spinal anaesthesia almost spoils the surgeon. It gives such wonderful relaxation and the field of operation is not soiled from bleeding. Spinal anaesthesia must be a preferred method to the surgeon. The anaesthetic should be administered with great caution and in minimum amounts, preferably not more than 150 milligrams even though it becomes necessary to supplement the spinal anaesthesia with gas.

The question as to the best method of resection is debatable. With thorough preliminary preparation, especially if preceded by external drainage, resection with anastomosis of some aseptic type, i.e., the Rankin anastomosis forceps or the Kerr suture method, is ideal. To a large extent, however, exteriorization and obstructive resection does away with all the accidents incident to suture operations and has the added advantage of temporary exteriorization of the Mikulicz oper-

serious import, for it may be an indication of the presence of a carcinoma of the colon. While we may investigate many cases and discover no evidence of malignancy we shall have the satisfaction of finding some that would otherwise be overlooked.

The abdominal surgeon should be "colon-conscious" in the sense that he should carefully palpate the entire colon as he does other intra-abdominal organs. Otherwise he may and some times does, overlook a lesion in the colon especially when a lesion present in some other organ may seem to explain the entire symptomatology.

Carcinoma of the sigmoid flexure is usually of the stenosing, scirrhous type, rarely producing a tumor, but very prone to cause obstruction. The usual lesion is small, spool-like, and therefore not palpable. This is in contradistinction to the conditions present in tumors of the right half of the colon. Here the tumor is most frequently in the cecum, is large, fungating, and may be palpable even to the patient himself. Such a tumor is prone to produce, without apparent cause, that arresting form of secondary anemia which is probably due to interference with the absorptive action of the cecum.

The mildness or vagueness of the symptoms is our undoing. For a long time the only presenting symptom is slight abdominal pain so mild perhaps that the discomfort is looked upon as so called "intestinal indigestion." The symptoms are of the type usually associated with minor ailments. However any change in the normal bowel habit that persists should be regarded with suspicion of cancer until careful study reveals the true cause of the change. So called alternating diarrhoea and constipation should not be depended upon for diagnosis, for this really means that there is a reservoir above the obstructed area that becomes so full that liquefaction gives rise to diarrhoea following a period of constipation. It is, therefore, really a late symptom. It is unfortunate that only the advent of obstructive symptoms brings the patient to the physician.

When constipation is a presenting symptom, how long should it be treated symptomatically without subjecting the patient to a barium enema or a thorough study to determine the cause of the constipation?

Constipation is so common and is dismissed so cavalierly that little attention is paid to it. It should be emphasized, however that unexplained constipation of more than transient duration, in an elderly person, is an indication of the presence of carcinoma. If the constipation is of sudden onset and persists in an individual of otherwise

normal bowel habit, it is a sign not to be passed by. It should be regarded as an evidence of malignancy in every case, until the presence of a new-growth has been proved or disproved.

Recent gaseous distention and borborygmi are suggestive of partial obstruction. Rumbling of flatus is aggravated by purgation. Pain is due to the obstruction and to the resulting trauma from the forcible propulsion of feces. There may be present blood in small quantities due to trauma to an ulcer. Pain of some degree is present in about 65 per cent of cases without obstruction. Diarrhoea, usually of the mucous type, occurs in about a third of the cases. The diagnosis of colitis always requires considerable support as many times its presence is questionable, and in elderly people should not be confused with carcinoma. When pain is increased after eating, it is usually thought to be gastric in origin. Some patients have therefore abstained from food and have consequently lost weight. In fact, weight loss has occurred in over two-thirds of the patients. Palpable and visible peristalsis may occur with the pain and should be patiently sought for and demonstrated if possible, for it is a very valuable sign—often the patient can designate the exact site at which the pain and really the stoppage of the bowel seem to occur.

The appearance of blood from the rectum is a danger signal. A thorough, painstaking, careful study should be made to determine the source and character of the blood. While bleeding is a frequent symptom of hemorrhoids, the source of the bleeding should be determined to avoid inflicting the patient with a blind diagnosis. Bleeding from the rectum should always call for a most thorough digital and proctoscopic examination and the use of any other means to locate, absolutely if possible, the cause and the exact site of the bleeding. Examination of the faeces by Weber's or some other reagent for occult blood is useful as in the majority of patients occult blood is present at one time or another. Bleeding should never be waited for or depended upon as necessary to complete the diagnosis.

Growths in the lower part of the sigmoid can be readily visualized by means of the skillful employment of the sigmoidoscope.

In the earlier stages, the stenosing, annular type of lesion of the sigmoid is very readily recognized by means of the X-ray. The barium enema reveals a narrow deforming, constricting area that is very definite and always single, in complete contradistinction to the "string of sausage" appearance that is sometimes found in ulcerative colitis, in the cases in which the colon is some-

HERNIA IN THE INFANT

WITH A REPORT OF THIRTY-ONE CASES

W J BLEVINS, M.D., WOODLAND, CALIFORNIA
From the Department of Obstetrics Woodland Clinic

IN the routine of our obstetrical department, observation of the newborn is practiced at frequent intervals until the age of one year. In following this routine what has appeared to be a rather unusual number of herniæ has attracted our attention. Inasmuch as the frequency of herniæ noted in our series appears to be very much greater than that ordinarily observed and inasmuch as the type of some of these herniæ was very unusual, it was felt that sufficient material for discussion of this subject was at hand.

In a series of 906 births in the Woodland Clinic Hospital, 20 herniæ were observed. In addition to these, 11 infants suffering from the same disability were brought to the outpatient department. The 32 herniæ, which were observed in the aggregate of 31 patients, were distributed as to age and type as is noted in Table I.

It is not our purpose to go into detail as to the etiology and embryology of herniæ, as a number of very competent papers on this subject are in the literature, notably those of Bryan, Fould, and Customs. It is, however, our feeling that all herniæ are congenital, the actual herniation being produced by some increase in intra-abdominal tension forcing abdominal contents into a potential hernial sac. In the event this occurrence does not take place it seems quite reasonable that either spontaneous recovery may ensue and a complete cure be effected by nature, or the hernia may still remain potential and not become clinically present until some strain in later life.

Many of these herniæ are observed before the infant is dismissed from the hospital, while others

may occur within the following 2 or 3 months. Potential herniæ as stated may become actual, due to increase in intra-abdominal tension especially from excessive crying of a child or straining at stool. The sac may contain any of the abdominal viscera and in female infants it has been our experience to find the adnexa present, either in whole or in part, in 4 cases. In 1 case, an undescended testicle was found in the contents of the sac, and in this event it is quite necessary that proper reduction embody very careful attention to this organ.

Incarceration is quite the rule in these infantile herniæ, and occasionally strangulation may occur. The symptoms of this accident are chiefly fretfulness, and excessive crying. Occasionally vomiting may occur due either to excessively vigorous crying or an actual obstruction, through actual kinking of the intestine.

It has been stated that strangulation is the result of crying of the child, but it would seem more logical to assume that the crying was a result, rather than a cause.

The use of a truss does not seem to be logical. Its application is beset by many hazards as the child is unable to co-operate in retaining it properly. Excoriation may result from friction and it is quite possible that incarceration and possible strangulation may result from the use of a truss. In the event that this does occur with excoriation at the site of the hernia and surgery becomes necessary, a very difficult technical procedure is necessary because of infection already present at the line of incision.

TABLE I.—DISTRIBUTION OF HERNIÆ AS TO TYPE AND AGE AT TIME OF OPERATION

Age in Months	M	F	Right indirect inguinal	Left indirect inguinal	Right direct inguinal	Left direct inguinal	Bilateral indirect inguinal	Umbilical	Right femoral
0-1		1	1						
1-	1	1	1			1			
2-6	6	2	2		3			2	1
6-12	2	2			3			1	
12-24	1	1	1					1	
24-42	8	1	4	2	1		1	1	
Total	18	8	9	2	7	1	1	5	1

ation. The present day method of removing all of the adjacent lymph nodes can be utilized. The immediate removal of the growth itself by occluding forceps on both limbs of the gut does away with the undesirable presence of the growth and the likelihood of cancer implantation on the wound which has been computed to be about 7 per cent. The proximal occluding clamp can be removed on the second or third day. The lower forceps may be left until it becomes detached. Restoring the continuity of the tract by an enterotomy forceps and the tertiary procedure of closing the fistula extraperitoneally prolongs the stay of the patient in the hospital all told only 10 days longer than suture anastomosis, as reported by Cheever (53 versus 43 days). If the patient doesn't mind the protracted presence of the fecal fistula, it may be left to close spontaneously as happens in about half of the cases. Rankin referred to one series of exceptionally brilliant results in cases in which resection was done by the obstructive method. This series comprised 33 consecutive cases with 1 death, a mortality of 3.3 per cent. The prediction has been made that a hospital mortality below 10 per cent may become uniform. In his resections of the area from the middle of the transverse colon to the rectosigmoid junction, the mortality was 7.4 per cent. The obstructive resection is not well adapted to the very fleshy or to the densely adherent growths. In the Brigham series the mortality for the exteriorizing operation is given as 21.2 per cent against 14.3 per cent in resection with immediate suture. The mortality of all cases was 19.3 per cent. Grey Turner's results were about the same. It might be suggested that the surgeon naturally selects the more favorable group for suture and the more forbidding for exteriorization which is as it should be. At time of operation, a searching study can be made of the liver, the prevertebral glands along the course of the great vessels to their division, then of the pelvis, and, lastly of the growth and its regional extension.

Lesions at the rectosigmoidal juncture nearly always make necessary the sacrifice of the sphincter and the establishment of a permanent colostomy. The one stage combined abdominal and

perineal operation through the midline incision with inguinal colostomy may be performed in selected cases if the surgical staff feel like carrying it. Ordinarily the two stage method is preferable and more generally applicable. In the one stage, the entire sigmoid above the growth and downward may be placed below the peritoneum which is closed over it, the abdomen closed, and the growth and lower rectum with the sphincter removed after a few days or the perineal feeding of the anus and rectum up to the peritoneum may be done first. The entire growth is then placed in rubber tissue and the parts are closed. Through an abdominal incision the sigmoid, well above the cancer, is sectioned, and the proximal portion is brought out as a permanent colostomy. The essential step is the ligation of the inferior mesenteric artery just above its division into the superior hemorrhoidal and mesal branches. This gives an absolutely bloodless field for the remainder of the operation. The rectosigmoid which has been enucleated down to the portion that was freed from below with all of the regional glands adjacent, is then lifted out from above. This is the technique recently described by Rankin. In only exceptional instances can the lower rectum be safely preserved in rectosigmoidal lesions and the proximal and distal segments united. The older combined first stage colostomy for rectosigmoidal and rectal cancer followed by a secondary extirpation from below (Kraske) does not afford the wide extirpation that the enucleation from above does.

Grey Turner reported that 50 per cent of the patients survived operation and were alive and well 5 years after operation or were known to be dead of other causes—this may well be taken as a surgical objective.

In cancer of the sigmoid colon the lesion is sequestered, the symptoms are insidious and insensitizing, the diagnosis is delayed, the frequency of obstruction and its lethal results are dispiriting, yet the end-results make all the requisite skill and care well worth while.

Exteriorization and obstructive resection when possible is the safest operation for the patient and the simplest procedure for the surgeon.

glandular malfunction, surgery was not indicated. Two of them were given rather large doses of thyroid extract and within a period of 2 years the separation had completely closed and the children were well in so far as the hernia was concerned. The third child was put on the same regimen but the co-operation of the mother could not be obtained, and as a result the child died after a period of time without any evidence of closure of the defect.

The fact that two of these children had spontaneous recovery, after operation was refused, does not justify a stand which would eliminate the surgical procedure, as it is noted in many of these cases that the sac contained a large amount of abdominal viscera.

The treatment of the simple umbilical herniæ in many cases may be purely a medical procedure. It has been found that many children obtain complete relief by the application of a pad of gauze held firmly in place by adhesive plaster, the plaster extending well to the side of the abdomen and pulling the rectus muscles together. After a period of several months the relaxed ring generally contracts, with elimination of the hernia. However, if any of the viscera protrude through, it is our advice that surgery be adopted, and the double flap operation or the operation of Fould be performed.

The surgical procedure adopted varies with the individual hernia, but the operations of Ferguson and Andrews-Bassini have been used chiefly in the inguinal region. Again, it is well to stress the point that these procedures should be exactly the same as those which would be adopted in a similar case in an adult.

SUMMARY

In 906 consecutive hospital patients 20 herniæ were found before these children reached the age of 42 months. This, of course, does not include many children on whom a follow-up was not

obtainable. In addition to these 20 herniæ 11 others were observed within this age range.

Three of these 906 newborn were cretins with widely separated rectus muscles. Twenty-six of these children were operated on for radical herniorrhaphy without any mortality and without recurrence in any case.

RECOMMENDATIONS FOR TREATMENT

- 1 All inguinal and femoral herniæ persisting over a period of 1 month should be referred to a surgeon for hernioplasty. In the event incarceration is noted at any time, immediate surgery should be practiced as strangulation might intervene by reason of torsion.

- 2 A truss is not to be used in any event as the danger attendant on its usage greatly outweighs the advantages which are occasionally derived.

- 3 The true congenital umbilical hernia with abdominal contents in the sac should be referred to the surgeon for operation a few days after birth. The enlarged umbilical ring which protrudes when the child cries should be treated conservatively through the application of gauze pad held by adhesive. In the event the ring does not close at the end of 6 months the child should be referred for operative procedure.

- 4 The large hernia in the cretin, which is probably more aptly described as a complete separation of the recti, is not a surgical condition and all treatment should be directed against the primary etiological factor through the use of thyroid extract.

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SURGERY GYNECOLOGY AND OBSTETRICS

TABLE II.—TABULATION OF THIRTY-ONE CASES OF HERNIA IN INFANTS NO RECURRENCE

Series No.	Case No.	Sex	Age in mos. at onset	Age in mos. at operation	Type of hernia	Type of repair	Contents of sac and remarks
	17398	M.	30	30	Indirect inguinal, right	Ferguson	Cecum and very large appendix, strangulated
	18673	M.		42	Indirect inguinal, right	Ferguson	Distended small bowel
3	20346	M.	16	30	Indirect inguinal, right	Ferguson	Reduced before operation
4	2161	M.	20	30	Indirect inguinal, right	Andrews-Barnes	Reduced before operation
5	2131	M.	3	3	Direct inguinal, right	Andrews-Barnes	Strangulated mass of bowel
6	22137	M.		3	Direct inguinal, right	Ferguson	Reduced before operation
7	2314	F	11		Direct inguinal, right	Andrews-Barnes	Right fallopian tube, right ovary and portion of broad ligament well incised, strangulated
8	24134	M.		6	Indirect inguinal, right	Ferguson	Long appendix and portion of cecum incarcerated
9	26744	M.		3	Direct inguinal, right	Andrews-Barnes	Small bowel
10	27512	M.		4	Direct inguinal, right	Ferguson	Incarcerated portion ileum
	2771	M.			Indirect inguinal, right	Andrews-Barnes	Reduced before operation
13	28143	F	Birth	None	Direct inguinal, left	None	Recovery after month. No recurrence after years
14	28677	F		36	Indirect inguinal, left	Ferguson	Incarcerated bowel
15	18603	M.	34	34	Indirect inguinal, left	Andrews-Barnes	Reduced before operation
16	12744	M.	34	34	Indirect inguinal, left	Ferguson	Reduced before operation
17	20950	M.		36	Indirect inguinal, left	Andrews-Barnes	Both ovaries, both tubes, uterus. Strangulated
18	24213	F		36	Indirect inguinal, bilateral	Ferguson	Reduced before operation
19	1466	F	Birth	36	Direct inguinal, left	Ferguson	Reduced before operation
20	27905	M.	Birth		Unilateral	Ford	Small intestine
	29759	F	Birth	3	Unilateral	Double-flap	Small bowel
22	12098	F	Birth	18	Unilateral	Double-flap	Incarcerated omentum
23	12731	F	Birth		Unilateral	Double-flap	Incarcerated omentum
24	17749	F			Unilateral	Double-flap	Abdominal viscera
25	20470	F	Birth	None	Ventral, right	Simple	Right fallopian tube, ovary, cecum of uterus separated—necrotic
26	17118	F	Birth	None	Ventral	None	Abdominal viscera. Cecum
27	14096	F	Birth	None	Ventral	None	Abdominal viscera. Cecum
28	12776	M.		3	Indirect inguinal, right	Ferguson	Portion of bowel strangulated
29	17309	M.		30	Indirect inguinal, right	Andrews-Barnes	Reduced before operation
30	22473	M.	3	30	Indirect inguinal, right	Ferguson	Reduced before operation
31	17944	M.		None	Direct inguinal, right	None	Spontaneous recovery

It would seem, in view of the fact that 26 infants from 3 weeks to 42 months have been treated surgically without a death in the series and with no recurrence, that we are justified in stating that the treatment of hernia in infants is quite satisfactorily and safely handled by the application of radical surgical procedures. The technique in the infant is not different from that used in the adult. It is true that the tissues are

much more delicate and the procedure is correspondingly difficult, but in no case have these difficulties been of any great moment.

One type of hernia which is included in this series falls into a different classification. It so happens that 3 of these infants had large ventral hernie as well as very marked hypothyroidism. There appeared to be a complete separation of the rectus muscles and it was felt that, in view of their

glandular malfunction, surgery was not indicated. Two of them were given rather large doses of thyroid extract and within a period of 2 years the separation had completely closed and the children were well in so far as the hernia was concerned. The third child was put on the same regimen but the co-operation of the mother could not be obtained, and as a result the child died after a period of time without any evidence of closure of the defect.

The fact that two of these children had spontaneous recovery, after operation was refused, does not justify a stand which would eliminate the surgical procedure, as it is noted in many of these cases that the sac contained a large amount of abdominal viscera.

The treatment of the simple umbilical hernia in many cases may be purely a medical procedure. It has been found that many children obtain complete relief by the application of a pad of gauze held firmly in place by adhesive plaster, the plaster extending well to the side of the abdomen and pulling the rectus muscles together. After a period of several months the relaxed ring generally contracts, with elimination of the hernia. However, if any of the viscera protrude through, it is our advice that surgery be adopted, and the double flap operation or the operation of Fould be performed.

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obtainable. In addition to these 20 herniæ 11 others were observed within this age range.

Three of these 906 newborn were cretins with widely separated rectus muscles. Twenty-six of these children were operated on for radical herniorrhaphy without any mortality and without recurrence in any case.

RECOMMENDATIONS FOR TREATMENT

1. All inguinal and femoral herniæ persisting over a period of 1 month should be referred to a surgeon for hernioplasty. In the event incarceration is noted at any time, immediate surgery should be practiced as strangulation might intervene by reason of torsion.

2. A truss is not to be used in any event as the danger attendant on its usage greatly outweighs the advantages which are occasionally derived.

3. The true congenital umbilical hernia with abdominal contents in the sac should be referred to the surgeon for operation a few days after birth. The enlarged umbilical ring which protrudes when the child cries should be treated conservatively through the application of gauze pad held by adhesive. In the event the ring does not close at the end of 6 months the child should be referred for operative procedure.

4. The large hernia in the cretin, which is probably more aptly described as a complete separation of the recti, is not a surgical condition and all treatment should be directed against the primary etiological factor through the use of thyroid extract.

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RESECTIONS OF THE RENAL PELVIS AND OTHER PLASTIC OPERATIONS FOR HYDRONEPHROSIS

END-RESULTS IN THIRTEEN CASES¹

WALTMAN WALTERS, M.D. F.A.C.S., ROCKFORD, ILLINOIS
Division of Surgery, The Mayo Clinic

THE conservative treatment of hydronephrosis centers around the surgical principle that adequate relief of the obstruction at the ureteropelvic junction be consummated with minimal disturbance of renal and ureteral tissue. I shall limit this consideration, however, to that group of patients with hydronephrosis on whom plastic operations on the renal pelvis, or on the ureter at the ureteropelvic junction, were felt to be indicated.

Most cases of hydronephrosis are the result of definite obstructions at the ureteropelvic junction, and failure to determine and demonstrate the cause of such obstruction, except in exceptional cases is due not to their absence but to failure to recognize them. In my experience, the causes of such obstructions, for the most part, have been (1) anomalous renal blood vessels, (2) peripelvic connective tissue causing angulation or collapse of the ureter (3) narrowing of the ureter at the ureteropelvic junction which was due to a sub-epithelial fibrosis, and (4) obstruction of the ureteropelvic junction which was due to lateral insertion of the ureter.

The indications for conservative surgical procedures for hydronephrosis are limited to that group of cases in which the hydronephrosis involves both kidneys, or in which it involves one kidney of which sufficient parenchyma remains to justify preservation of the organ. It is hardly necessary to mention the necessity of conservative measures in cases in which only a solitary kidney remains.

In the group of cases which forms the basis of this paper the removal of the obstruction has been combined in some cases with nephrostomy and nephropexy. Nephrostomy has been employed when there has been infection within the kidney prior to operation, and nephropexy in cases in which the upward fixation of the kidney has seemed to permit of a better line of dependent drainage from the renal pelvis to the ureter. In many of the cases the hydronephrosis was bilateral.

The reasons for various operative procedures, and reports of cases illustrating them will next be given.

DIVISION OF CONNECTIVE TISSUE SHEATHS OR OF BANDS WHICH CAUSED ANGULATION AND COLLAPSE OF THE URETER, WITH OR WITHOUT NEPHROSTOMY

Division or removal of a connective tissue sheath which has caused collapse of a ureter often will suffice to permit a distended pelvis completely to empty itself. One of the most interesting cases of this type was that of a woman with bilateral hydronephrosis. Although dilatation of the left renal pelvis and calyces was great (Fig. 1 A), there was sufficient renal parenchyma to allow of an attempt being made to preserve the kidney and with the right kidney also hydronephrotic, preservation of the kidney seemed essential. A dense sheath of connective tissue had caused collapse of the ureter against the renal pelvis, and when this was freed, the pelvis was enabled completely to empty itself. Temporary nephrostomy was done. Before the patient was discharged to return home, the size of the renal pelvis and calyces had decreased by 50 per cent (Fig. 1 B). Three months later when she returned for re-examination and operation on the other kidney, the left renal pelvis and calyces had assumed normal proportions. An abstract of her case follows.

CASE 1. A married woman, aged 30 years, August 17, 1930, gave a history of intermittent left renal colic for 3 years. Cystoscopic examination revealed dilatation of function of both kidneys; excretion of indigo-carmin from the right kidney was graded + and from the left, 2. There was some infection in both kidneys. An intravenous urogram gave evidence of bilateral hydronephrosis graded on the right, and 4, on the left. At operation August 29 a dense sheath of connective tissue collapsing the ureter against the distended pelvis was excised, following which the ureter assumed normal, dependent position and the pelvis could be seen to empty itself spontaneously. Because of the dilatation of the calyces in association with the dilatation of the pelvis, and the considerable amount of normal renal parenchyma remaining, temporary nephrostomy was done. October pyelogram of the left kidney gave evidence of reduction in the size of the pelvis and calyces by 50 per cent. The patient was allowed to return home with nephrostomy tube in place.

The patient returned to the clinic December 8, at which time the left renal pelvis seemed to be normal in size; pus in the urine from the left kidney was graded 2, and in that from the right kidney. There had been considerable improvement in the function of the left kidney evidenced

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by its ability to excrete indigocarmine. December 23, the right kidney was exposed. It was approximately 5 centimeters below its normal position. Connective tissue had caused the ureter to become angulated at the ureteropelvic juncture. The extrarenal pelvis measured approximately 2.5 centimeters. Due to the fact that this was the better kidney, and that it had not given symptoms of obstruction, establishment of better drainage seemed the only procedure necessary. Nephropexy was done by placing interrupted sutures in the lumbar fascia and the fibrous capsule of the kidney. A strip of iodoform gauze was temporarily placed under the lower pole of the kidney, assisting to maintain it in position. An intravenous urogram January 20, 1931, showed the dilatation of the right renal pelvis to have persisted. The left renal pelvis was practically normal in size, although the upper calyx was somewhat dilated.

In the latter part of May, 1931, the patient reported her condition to be very good, she was able to do her housework without fatigue, although at times she had slight pain in the left renal region. In a letter dated October 26, 1931, she made a similar report. She has gained 5 pounds. Her urine remains cloudy.

In reviewing this case, it would seem that an excellent result had been obtained from operation on the left kidney, which was the side from which the patient had had subjective symptoms of obstruction. Since the patient has had no subjective symptoms of right renal obstruction, the results of operation on the right kidney can be determined only after passage of sufficient time to show whether obstruction will develop or whether the dilated right renal pelvis will be adequately drained by the ureter, and whether the pelvis will return to normal size. My feeling is that had nephrostomy been done at the same time it was done on the left kidney, contracture of the pelvis of the right kidney would have occurred.

A second patient, of much the same type, obtained similar relief of symptoms and improvement in renal function by a like procedure. An abstract of the case follows:

CASE 2 A man, aged 42 years, gave a 15 years' history of swelling in the right flank, which became very painful at times, and suddenly disappeared as urine was voided. There frequently was fever with these attacks, but the patient was not aware that there was pus in the urine. He had had several severe attacks of right renal colic. His last severe attack had been in November, 1930. The kidney had been tense, he said, and it had been necessary to drain it with the ureteral catheter. At that time it had been found that in addition, function of the left kidney was 20 per cent of normal, and operation on the right kidney had been denied. At the clinic, it was found that his weight was 15 pounds less than what he said was his normal weight. Pus in the urine was graded 4. The concentration of urea was 20 milligrams in each 100 cubic centimeters of blood, and excretion of phenolsulphonephthalein was 15 per cent. Cystoscopic examination revealed bilateral hydronephrosis. The sac on the right was huge, and the kidney without function, whereas that on the left had a capacity of 200 cubic centimeters, with apparently fair function of the kidney. Pus in the urine from the right kidney was graded 2, and that from the left kidney 1.

January 16, 1931, an operation, consisting of removal of peripelvic fibrous tissue at the ureteropelvic juncture was done, with division of an anomalous artery and vein. Nephrostomy and nephropexy were done secondarily. The kidney was hugely dilated, 25 centimeters in diameter, and its pelvis contained 800 cubic centimeters of purulent, cloudy urine. Approximately 50 per cent of the solid portion of the kidney remained. Following removal of the obstructions, the ureter straightened and assumed a position dependent to the renal pelvis, effectively draining it. It seemed that if the pelvis should not drain satisfactorily, plastic resection could be done at a later time. The post-operative course was uneventful and the patient was dismissed February 17, returning home 10 days later, with the nephrostomy tube in place. June 2 he returned for re-examination. He had had no further pain, no fever, no chills, and had regained his normal weight. The voided urine contained pus graded 4. Pus in the urine from the right kidney was graded 2, and that from the left, 1. The nephrostomy tube was removed. An intravenous urogram (65 minutes) gave a good outline of the left kidney, the right showed dilated calyces which were well outlined. The patient again returned home without the nephrostomy tube, and with the incision healed. October 31, 1931, he reported his condition as excellent. His urine contained pus.

DIVISION OF ANOMALOUS BLOOD VESSELS

Whether division of anomalous blood vessels obstructing the ureteropelvic juncture can be performed without too great disturbance of the blood supply to the kidney should be determined before they are severed, by temporarily occluding them by means of a rubber covered hæmostat. The portion of the kidney supplied by this blood vessel, within a few seconds will turn almost blue. With removal of the hæmostat, circulation is restored and the normal color returns. It will have to be a matter of personal judgment in such cases as to whether the portion of the kidney the blood supply of which is not interfered with, is sufficient to allow ligation of the anomalous vessels with safety. If the portion of the kidney supplied by anomalous blood vessels is too extensive to allow of division of these vessels another procedure, such as implantation of the ureter in a new place on the pelvis, or resection of the renal pelvis, must be done. Even after division of the anomalous vessels, the ureteropelvic juncture must be at the dependent portion of the pelvis, and the pelvis must be drained efficiently or symptoms of obstruction will continue, necessitating a secondary operation to accomplish this result. The following case is illustrative.

CASE 3 A man, aged 20 years, in March, 1927, had dull aching pain in the left renal region when standing. It was relieved by lying down. In May, 1927, before he came to the clinic, an aberrant anomalous blood vessel of the left kidney had been ligated and divided. He was then free from trouble for 2 months, but in July the pain returned, was more severe than before, and was accompanied by nausea. He continued to have attacks at intervals of from 1 to 3 months for relief of which morphine was required.

Later he said, the pain had not entirely disappeared for several days.

Urinanalysis gave negative results. An intravenous urogram August 9, 1930, gave evidence of bilateral hydro-nephrosis. On the left side was a large sac, with evidence of the shadow of the pelvis was clearly visualized. The ureter seemed normal. The hydro-nephrotic sac on the right side was of moderate size, and the kidney apparently was of good function. There was obstruction at the ureteropelvic junction, but this gave no symptoms.

August 9, 1930, resection of the renal pelvis, with temporary nephrostomy was performed on the left side. The renal pelvis was dilated and was of a capacity of about 70 cubic centimeters. The kidney was bound in the left renal fossa by means of connective tissue. The ureter and orifice was on the lateral aspect of the renal pelvis. The renal parenchyma was approximately 60 per cent of normal in mass. The renal pelvis was resected, and number 14 catheter inserted, to serve as temporary nephrostomy. Also, a ureteral catheter was inserted through the cortex and down the ureter. The catheters were left in place for 5 days. September 16, 1930, an intravenous urogram gave evidence of no change in size or outline of the pelvis or calyces, although the left pelvis was better filled than in the previous roentgenogram; both pelvis were dilated, general condition excellent, and the patient was healed. In a telegram October 27, 1931, he stated that he has had no pain in the left renal region since the operation and that his general health is excellent. I have had several other cases in which excellent results have been obtained by this procedure.

REIMPLANTATION OF THE URETER INTO THE RENAL PELVIS

Reimplantation of the ureter has been carried out in 3 cases, in 2 of which the cause of obstruction was unusually large, anomalous renal arteries and veins, division of which did not seem to be advisable. In the third of these cases (Case 6) the obstruction was the result of subepithelial fibrosis. The portion affected was approximately 13 centimeters long and lay at the ureteropelvic junction, where it narrowed and practically occluded the ureter. This region of subepithelial fibrosis is illustrated in Figure 5. It was resected and the ureter was reimplanted into the dependent portion of the pelvis. In this case, too soon following the operation, it is a definite report of the result to be made. In the 3 other cases (Cases 4 and 5) however sufficient time has elapsed, and a study subsequent to operation by cystoscopy and intravenous urography leads me to believe that successful results have been obtained, this in spite of the fact that in one of the cases (Case 4) pyelonephritis developed immediately subsequent to operation requiring intravenous injection of neomphenamine and drainage by catheter of the renal pelvis for a short time. The other of the 2 patients

(Case 5) had an uneventful convalescence, and the return of the renal pelvis and calyces to normal in the 3 months subsequent to operation has been phenomenal. Complete relief of symptoms of obstruction have been obtained in these two cases.

CASE 4. A man, aged 23 years, had a history of intermittent right renal colic of 3 years' duration, for which cocaine was required for relief. The urine contained pus of infection in either kidney and showed normal function. A cystogram of the right kidney June 25, 1930, gave evidence of dilatation of the calyces graded 1, and of the normal. A pyelogram of the left kidney June 29 gave evidence of a normal pelvis, normal calyces, and normal ureter. July 4, 1930, reimplantation of the right ureter was carried out, an artery and vein crossing the ureteropelvic junction was the cause of the obstruction. The anomalous artery was 3 millimeters in diameter and seemed too large to destroy. The ureter was removed from the pelvis and was reimplanted in the dependent portion of the pelvis, away from the anomalous vessels. A ureteral catheter, passed through the cortex and down the ureter was used temporarily as a splint and a scaffold for healing. The catheter was removed on the twelfth day after operation, subsequent to which fever developed. July 21 a catheter was introduced through the cystoscope into the right ureter. There were no obstructions but a considerable quantity of purulent material was withdrawn. Neomphenamine was given on two occasions in the first 2 weeks in August, and this was followed by cessation of the colic. August 30, 1930, the general condition was satisfactory. A pyelogram gave evidence of dilatation of the calyces of the right kidney, graded 3-4, the pelvis was practically normal (Fig. 3B). From the right kidney no calic centimeter of clear urine was withdrawn. The function of both kidneys was fair and equal, no obstruction to the catheter was encountered. September 7 the patient's general condition was excellent and he was discharged. In a letter dated September 20, 1930, the patient stated that he was in good condition and had had no further trouble since recovery from his operation. September 6, 1931 the patient's father reported that his son's condition was good and that he was satisfied that the operation was successful.

CASE 5. A boy aged 6 years, gave history on June 8, 1931 of intermittent left renal colic for 9 months; the attacks of pain were from 8 to 12 hours in duration. On the right kidney was graded 4, that from the left kidney 1, evidence of normal right renal pelvis the left kidney was not visualized (Fig. 4A). An intravenous urogram gave evidence of dilatation of the calyces of the left kidney. At operation, performed June 1, dilatation of the extrarenal pelvis was graded 3, 4, dilatation also seen to be distended and it contained no calic centimeters of clear urine. Obstruction was due to an anomalous artery and vein crossing the ureter at the ureteropelvic junction. The artery measured 3 millimeters in diameter and the vein was of similar size. Temporary occlusion of these vessels brought about blood distention of the lower pole of the kidney for a distance of 5 centimeters; therefore, it seemed inadvisable to destroy the blood supply of so much of the kidney. The ureter was removed and reimplanted in the dependent portion of the pelvis, away from the anomalous vessels. A ureteral catheter, used as a splint, was brought out through a small opening in the renal cortex (Fig. 5). Postoperative convalescence was

uneventful, and the patient was dismissed from the hospital on the sixteenth day following operation, at which time the ureteral catheter was removed.

An intravenous urogram July 13 gave a good shadow of the left kidney, and indicated that there was dilatation of the pelvis and calyces (Fig 4B). At that time the patient was presented at the meeting of the staff of The Mayo Clinic and shortly afterward returned home. At my request, he returned September 28, stating that he had had no further renal colic. He appeared to be in excellent condition. An intravenous urogram gave a practically normal shadow of the left renal pelvis and calyces (Fig 4C).

CASE 6 A married woman, aged 23 years, on August 3, 1931, gave a history of pyuria that first had been noted in the course of pregnancy 5 years previously. Two weeks before she came to the clinic, she had noticed pain in both renal regions, with frequent and burning urination.

Urine in the urine was graded 3. A diagnosis of bilateral hydronephrosis, with fair function of the right but poor function of the left kidney was made. Operation, August 8, consisted of reimplantation of the right ureter into the renal pelvis. The cause of the obstruction appeared to be narrowing or contracture of the right ureter over a distance of approximately 1.5 centimeters, extending downward from the pelvis. This portion of the ureter was about one-third to one-fourth of its normal size. The ureter was severed from the pelvis after it had been ligated. The narrowed portion was excised and the normal portion attached to the dependent portion of the renal pelvis. A ureteral catheter was used as a splint by bringing it out through the cortex, as a means of effecting temporary nephrostomy. Microscopic examination of the excised portion of the ureter resulted in a report of "subepithelial fibrosis" (Fig 2). The postoperative course was uneventful until the catheter was removed on the sixteenth day after operation. The following day, moderate phlebitis developed in the left internal saphenous vein. Fever continued, and a ureteral catheter was passed into the right renal pelvis. Cloudy urine was obtained. August 28 the catheter by which nephrostomy was maintained was reinserted, and 250 cubic centimeters of thick purulent material was drained out. Convalescence was uneventful. Investigation of the right kidney by pyeloscopy revealed that the pelvis did not empty. October 6, the function of the right kidney, as estimated by watching the discharge of indigocarmine through the nephrostomy tube was graded 2+, no blue came down into the bladder within 15 minutes, nor could any phenolsulphonethylamine be injected into the pelvis through the ureteral catheter because of obstruction at the ureteropelvic juncture. The diagnosis of this complicating condition was obstruction at the ureteropelvic anastomosis. October 26, the patient's general condition was excellent and it was decided to perform exploration of the ureteropelvic juncture in another week. That time had not arrived when this paper was being written.¹

The probabilities are that the infection in the right kidney caused a narrowing at the point of anastomosis. That no obstruction was present until this occurred, however, is evidenced by the fact that 3 days subsequent to removal of the ureteral catheter which passed through the cortex of the kidney and down the ureter it was possible to pass a ureteral catheter through the cystoscope into the renal pelvis without meeting obstruction.

URETEROPYELONEOSTOMY

The successful outcome following anastomosis between the dependent portion of the renal pelvis and the ureter of a patient with a solitary kidney, in the presence of acute and complete obstruction, leads me to emphasize the value of such anastomosis (ureteropyeloneostomy). This method of relieving the obstruction was chosen because I was thus able to accomplish the anastomosis with the least possible manipulation of the kidney. Regardless of the cause of the obstruction, it was complete. Report of the case follows.

CASE 7 In 1918 a man had undergone left pyelolithotomy for stone. Three days later, left nephrectomy had been performed. Both of these operations had been performed before he came to the clinic.

When I saw the patient August 11, 1928, he was 36 years of age, and gave a history of having had intermittent right renal colic for 2½ years, with pain. He had noted a mass in the upper part of the abdomen. Catheterization of the kidney had been followed by relief of pain. For a year and a half the patient had had attacks about every 2 months, with fever. A week before he registered at the clinic, a ureteral catheter had been inserted into the renal pelvis, and following its removal, symptoms had recurred and no urine had left the kidney. The catheter had been left in for 4 days.

On the patient's arrival at the clinic, his condition seemed excellent. The concentration of urea was 34 milligrams in each 100 cubic centimeters of blood and the return of phenolsulphonethylamine in the urine was 40 per cent. Cystoscopic examination August 15, 1928, gave evidence of marked hydronephrosis affecting the single remaining kidney. The sac had a probable capacity of 150 cubic centimeters. Function of the kidney was normal. Obstruction was detected at the ureteropelvic juncture.

Operation, August 15, 1928, consisted of ureteropyelostomy and temporary nephrostomy. The kidney was about twice its normal size, but the ureter was normal. The ureter passed up between two large renal vessels, one of which extended directly across the ureter, causing its collapse. Insertion of the ureter was at a higher level on the pelvis than normal, so that, with distention of the pelvis, the ureter was collapsed against it by the renal pedicle. The pelvis of the kidney was opened at the dependent portion by an incision 1.5 centimeters in length, and transverse incision of the ureter was made directly opposite. A ureteral catheter was placed in the pelvis of the kidney through the opening, and anastomosis was made with two sutures of chromic catgut. A number 30 catheter was used to effect nephrostomy. The postoperative course was uneventful and the patient was dismissed September 12 in excellent condition. June 10, 1929, he returned for re-examination, stating that he found it necessary to lie down once a day, usually in the afternoon, for the kidney to empty completely. On cystoscopic examination, return of indigocarmine was normal, retention of 30 cubic centimeters of urine was discovered, and angulation of the ureteropelvic juncture was detected. A number 10 Garceau catheter passed readily into the renal pelvis. It seemed that nephropexy would hold the kidney up in position, allowing it to empty completely. This was done June 26, 1929. The patient was dismissed in excellent condition July 8. In a telegram received from him October 28, 1931, he reported that his general health was excellent, that he continued to have retention of urine in the renal

¹A second plastic procedure at the ureteropelvic juncture was successful. The patient returned home December 18, 1931.

pelvis when on his feet, but that he obtained relief by lying down and elevating his left hip.

RESECTION OF THE RENAL PELVIS

Resection of the renal pelvis has been performed in cases in which the pelvis was greatly dilated, and the laterally inserted ureteral orifice was collapsed, with distention of the renal pelvis. In these cases, resection was carried out in such a fashion that when the pelvis was closed, the ureteral orifice became dependent, adequately draining the kidney.

On a previous occasion I presented the post-operative results in 3 such cases, in 1 of which the hydronephrosis was bilateral and marked. Six years ago, and adequate drainage of both kidneys continues, with complete relief of symptoms.

I am happy to be able to present this patient to you today. An abstract of his history follows:

CASE 2. A man, aged 54 years, had had repeated attacks of pyelitis since he was 20 years of age. He had been examined by various urologists, who had found vesical, bilateral hydronephrosis, and he had been given a long course of ureteral dilatation and pelvic lavage with only temporary relief.

Pre-operative cystoscopic examinations and pyelograms were made. Both kidneys were hydronephrotic. Pus, phospha-talein was present in the urine. Return of phospha-talein was estimated at 6 per cent and that of indigo-carmin was graded 3. Urography of the right kidney revealed that the pelvis and calyces were dilated to centimeters. Resection of the right renal pelvis, and nephropexy were performed November 22, 1931. The cause of the obstruction was an anastomosing artery 3 millimeters in diameter, which had caused cicatricial changes in the ureteral wall. The postoperative course was excellent. Cystoscopic examination December 23 revealed normal drainage of urine from the right kidney. There was no retention of urine in the right renal pelvis. Indigo-carmin was graded 2. There was evidence of retention in the pelvis of the left kidney and pus in the urine from that kidney graded 4. The return of phospha-talein from that kidney was 30 per cent in 5 minutes. The postoperative pyelogram of the right kidney gave evidence of a practically normal condition. A pyelogram revealed a greatly dilated left renal pelvis, with evident obstruction at the ureteropelvic junction.

The left renal pelvis was resected April 6, 1932. It was highly dilated, and contained approximately 150 to 400 cubic centimeters of infected urine. The renal parenchyma was reduced approximately half in size. Nephropexy and nephropexy were done at the same time. The patient left hospital wound opened and some purulent material drained from it for days. Cystoscopic examination June 12 disclosed normal apertures of urine coming from both ureteral orifices. June 7 indigo-carmin, graded 3 was excreted in the urine from the kidneys. A catheter to Garceau catheter was passed into both renal pelvises and there was no retention of urine in either.

The patient returned for re-examination July 1, at which time his general condition was excellent. He had had no further evidence of renal obstruction. June 4, 1932, he again returned for re-examination. He had gained 15 pounds and had not had any further pain, chills or fever. Cystoscopic examination disclosed that the urine from the right kidney was free of pus, and excretion of indigo-carmin had increased to grade 4. In the left kidney there was pus, and excretion of indigo-carmin from that kidney was graded 1. An intravenous urogram (uroductal) made June 4, 1932, had shown considerable pyelocystitis, largely intraluminal, with the ureters draining the dependent portions of the pelvis of both kidneys.

September 6, 1932, I operated for right hydronephrosis. Convalescence from this was uneventful. In a report received from the patient October 15, 1932, practically 3 years following the first operation, he stated that he was perfectly well, and had had no evidence of renal obstruction or infection. He was working each day. His urine was of neutral reaction, its specific gravity was 1.007 and it contained a few leucocytes and erythrocytes.

The case of a woman with bilateral hydronephrosis whose dilated renal pelvises were successfully resected is of equal interest in that she has had a continued excellent result, although but a year has elapsed since the completion of her operation. Report of her case follows:

CASE 3. The patient was a married woman, aged 41 years. May 20, 1930, she gave history of having had pyelitis for 3 years and hematuria 6 weeks before. Both lumbar pain gross blood had been seen in the urine. Both renal regions were tender. May 3 a pyelogram gave evidence of dilatation of the pelvis of the left kidney graded 4, and of the calyces, graded 3; dilatation of the pelvis of the right kidney was graded 3 and that of the calyces was graded 2 (Fig. 6A). The left ureter was not filled, but apparently as anastomosing inserted; the right ureter was not filled. Diffuse cystitis, graded 3, was present, and there was cicatricial erythema. The bladder was empty. Thirty-five cubic centimeters of clear urine was obtained with the ureteral catheter from the right renal pelvis. No indigo-carmin appeared from either side in 10 urine aspirated from the right renal pelvis was graded 3. The right kidney was of better function than the left.

July resection of the right renal pelvis, with nephropexy and temporary nephropexy were done. The extracapsular pelvis was dilated to approximately 4.5 to 5.5 centimeters in diameter. There was no demonstrable cause for the hydronephrosis except a fibrous band crossing the ureter which did not seem to constrict it. A catheter was passed through the cortex and down the ureter. The postoperative course was uneventful. A pyelogram made of the right kidney September 2, 1930, gave evidence that the renal pelvis was normal in size (Fig. 6B).

September 3, 1931, resection of the left renal pelvis, 2 cubic centimeters of turbid urine and secured 7.5 centimeters in diameter (Fig. 6C). There was nothing to explain the obstruction, and there were no anastomosing vessels. Postoperative course was rather protracted, due to interference with drainage of urine from the left lumbar incision. This ceased, however, December 2, and the patient was allowed to return home. October 1, 1931, her general condition was excellent. On one occasion in the last year



Fig 1 A, pre-operative intravenous urogram August 26, 1930, giving evidence of bilateral hydronephrosis, and huge dilatation of the pelvis and calyces of the left kidney B, Decrease in size of renal pelvis and calyces after operation C, postoperative intravenous urogram January 20, 1931 Reduction of left renal pelvis and calyces, with the exception of the upper calyx, to within normal limits

there has been some discomfort in the left renal region, for which temporary ureteral catheterization has been required. Otherwise the patient has felt so well that she has not returned for postoperative study of her left kidney.

CASE 10 An unmarried woman, aged 25 years, presented herself June 28, 1928, complaining of intermittent left renal colic of 3 months' duration. Hypodermic injections were required to give relief. She had had hæmaturia, accompanied by pain.

There was pus, graded 2, in the urine and renal function was normal, the concentration of urea was 26 milligrams in each 100 cubic centimeters of blood. Cystoscopic examination, June 30, gave evidence of early hydronephrosis on the left side, but of no infection and of good function of that kidney. The right kidney was normal. July 5, 1928, the extrarenal pelvis of the left kidney was resected, with reimplantation of the ureter into the dependent portion of the pelvis. The kidney was normal in size, consistency, and general appearance. No apparent cause for the obstruction was found. Some fever developed subsequent to the operation and July 19 a number 5 catheter was passed into the renal pelvis and 5 cubic centimeters of turbid fluid was removed, whereupon the fever subsided. Pyelitis was treated by irrigation, and drainage by catheter for pyelitis was given on several occasions. August 14, 1928, a pyelogram gave evidence of reduction in size of the left renal pelvis, the calyces were dilated to grade 3. September 18, 1928, because of pain in the right renal region, a pyelogram was made, which gave evidence of slight dilation of the calyces and pelvis of the right kidney, with retention of 15 cubic centimeters of urine but no infection. The patient was allowed to return home.

Subsequently the patient had good health, with no further obstruction of the left kidney. She returned for re-examination December 20, 1930, at which time her general condition was excellent. An intravenous urogram gave evidence of dilation of the calyces of the left kidney, graded 3, of the pelvis, graded 2. The right renal pelvis and calyces were dilated to grade 1. Cystoscopic examination disclosed no evidence of infection of the right kidney, excretion of indigocarmine was graded 3+ from the right

kidney and 2 from the left. From the right pelvis, 30 cubic centimeters of turbid urine was obtained. Function of the left kidney was reduced one-half. The patient was having some discomfort in the right lower portion of the abdomen. Sufficient evidence was not obtained for a diagnosis of appendicitis, so she was allowed to return home.

In a letter received October 27, 1931, the patient stated that she had had one attack of right renal pain since August with fever of 103 degrees F. Otherwise her general condition has been very good. She has gained 10 pounds.

One of the other most successful cases from the standpoint of a perfect appearing renal pelvis subsequent to resection was that of a woman, the details of whose case I shall not repeat, for it was presented on another occasion. I should like, however, to call attention to the remarkable return to normal of the pelvis of her kidney following resection. An abstract of her case follows.

CASE 11 The patient was a married woman, aged 42 years. She had had intermittent pain in the right renal region with dysuria, for 20 years. Cystoscopic and pyelographic examinations August 25, 1928 gave definite evidence of pyelectasis on the right side. The function of the right kidney apparently was markedly reduced, whereas that of the left kidney was normal. There was no infection in either kidney. Resection of the hydronephrotic extrarenal pelvis and nephropexy were performed September 11. The diameter of the pelvis, undistended, was 5 centimeters. Demonstrable obstruction was not found. Postoperative cystoscopic and pyelographic studies were made October 2. Excretion of phenolsulphonphthalein from both kidneys, in 3 minutes, was normal. The specific gravity of the urine from both kidneys was 1.008. Urography gave evidence that the pelvis and calyces of the



Fig. 2. Region of subepithelial fibrosis obstructing ureter

right kidney were almost normal. The patient was dismissed, October 3, in excellent condition; the incision was healed. February 12, 1930, she reported that she had had an excellent result from her operation and had had no further tracks of pain. In a telegram received from her, October 27, 1931, she reported that her condition was excellent. She had not had dysuria or renal colic since her operation, and she had gained 15 pounds.

POSTOPERATIVE COMPLICATIONS

Postoperative complications which may occur are (1) obstruction at the ureteropelvic juncture, with retention of urine in the renal pelvis (2) infection of the renal parenchyma, with formation of cortical abscess and (3) extravasation of urine about the kidney.

Obstruction of the ureteropelvic juncture usually manifests itself after removal of the nephrostomy tube, and is characterized by clinical symptoms similar to those of pyelonephritis; relief is obtained by drainage of the renal pelvis by means of a ureteral catheter or by reinsertion of the nephrostomy tube. If the latter becomes necessary before the tube is again removed, fluoroscopic pyelocopy or cystoscopic examination, with ureteral catheterization and the use of indigocarmine, should be carried out to see if the obstruction has released itself. On one occasion, after stasis within the renal pelvis had been relieved, the accompanying pyelonephritis was satisfactorily treated by intravenous injection of mercurochrome and neomycinamine. Infection within the renal parenchyma, especially if associated with cortical renal abscess gives that septic group of symptoms, characteristic of renal cortical abscess. Should cortical abscesses develop the kidney should be removed at the earliest

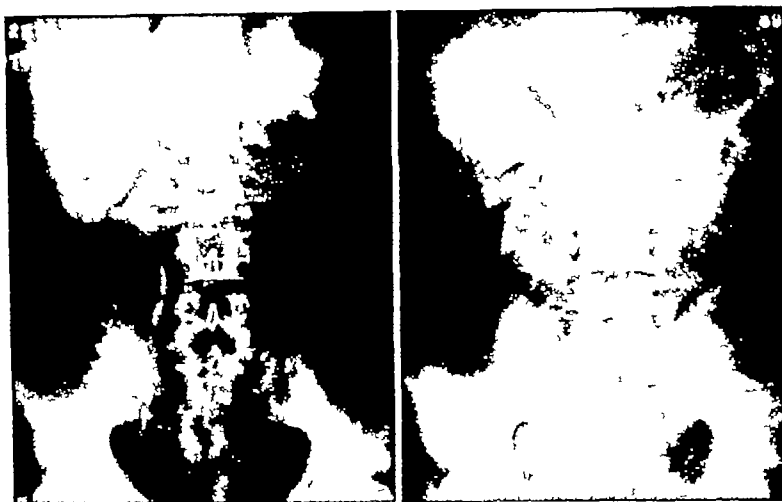
possible moment or else the patient is likely to lose his life as the result of dissemination of the infection.

CASE 2. A married woman, aged 40 years, had had intermittent renal colic on the right side for 20 years, associated with dysuria and hematuria. She had passed stones 22 years before. Renal function was normal. Pus in the urine was graded. Roentgenograms of the kidneys, ureters, and bladder gave negative results. Cystoscopic examination gave evidence of right hydronephrosis but no infection. Excretion of indigocarmine from the right kidney was graded 3 from the left, 4. Pyelogram gave evidence of an elongated, renal pelvis, dilated to grade 3, and of capacity of 60 cubic centimeters. The calyces were dilated to grade 3. October 8, 1930, the right renal pelvis was resected. A reason for the obstruction was demonstrable. The renal pelvis was 7 centimeters in diameter. Nephropexy was done secondarily. Subsequent to operation the patient's convalescence was perfectly satisfactory and she was discharged from the hospital on the twenty-second day following operation.

The patient re-entered the hospital November 4, for observation, because of feeling of malaise. Cystoscopic examination of that date revealed pus, graded 4, in the urine from the right kidney. There was no obstruction to the passage of a number 9 Garro's catheter up into the kidney. Her fever increased progressively during the next 3 days, and on November 8, the right kidney was removed. On pathological examination of the kidney it was found to be the site of hydronephrosis with infection associated with pyelocystitis. There were multiple cortical abscesses, and many stones, 5 of which were 4 to 5 millimeters in diameter. The patient was discharged from the hospital December 2. She returned home a few weeks later although several weeks elapsed after she returned home before she fully regained her strength. October 21, 1931, she reported her condition to be excellent.

In this case failure of the kidney to drain subsequent to operation might have been due to the soft renal calculi which did not cast a shadow in the roentgenogram, and the presence of which was unrecognized. Obviously, in this case primary right nephrectomy should have been done. Yet, prior to operation there was every favorable indication for a conservative plastic operation, with preservation of the kidney. Its function was practically normal and there was no apparent infection. The absence of demonstrable cause for obstruction at the ureteropelvic juncture was rather important for there is a possibility that the stones were the original cause of the hydronephrosis.

In the next case to be reported leakage of urine from the anastomosis did not manifest itself until after removal of the gutta serena Penrose drain. These drains are used as a routine in these cases, and are not removed for 7 days following operation. An accumulation of several hundred cubic centimeters of urine occurred about the kidney. After this accumulation of urine had been drained away the incision closed by secondary intention.



A

B

Fig 3 A, pre-operative pyelogram of right kidney B, postoperative pyelogram of right kidney Decrease in size of pelvis and calyces Ureter in dependent position.

cystoscopic examination, and a pyelogram revealed the right kidney to be functioning satisfactorily, and the urine to be transmitted from the kidney to the ureter

attack a month. A week before his registration at the clinic, accompanying the attack there was hæmaturia that had lasted for 3 days The urine contained pus graded 3, and erythrocytes, graded 2 Tests of renal function gave normal results Roentgenograms of the kidneys, ureters, and bladder were negative. Cystoscopic examination revealed hydronephrosis on the right side, the pelvis was dilated to grade 3, but the calyces were normal. Pus in the urine from the right kidney was graded 1, function of the right kidney was normal. Excretion of indigocarmine from the right kidney was graded 4, that from the left, 3 July

CASE 13 A man, aged 35 years, presented himself at the clinic in July, 1929 with an indefinite history of having had chills and fever for the preceding 12 or 15 years Attacks were accompanied by frequency of urination During the year before I saw him he had been having one



A

B

C

Fig 4 A, pre-operative intravenous urogram Left kidney not visualized B, intravenous urogram of left kidney 20 days after operation Dilatation of pelvis and calyces still present C, intravenous urogram, showing left kidney practically normal in size, approximately 3 months following operation

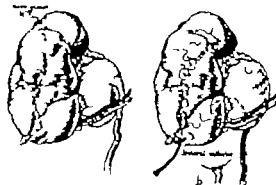


Fig. 5. Technique of reimplantation of the ureter into the renal pelvis

July 29, operation was performed, consisting of resection of the right renal pelvis and nephropexy. Extrarenal dilatation of the pelvis was graded 3; the pelvis measured approximately 4 centimeters. There was no demonstrable cause for the obstruction.

Progress following operation was satisfactory; there was no fever. Drainage was removed on the eighth day. Three days later August 6, fever developed. On catheterization of the right renal pelvis, 160 cubic centimeters of infected urine was withdrawn, containing pus graded 4. Fever continued, and August 9, a number 8 Garsia catheter was introduced into the region of the right renal pelvis, through the ureter and approximately 500 cubic centimeters of urine was withdrawn. With such large quantity of fluid, it seemed possible that extravasation and pocketing of urine outside the kidney had occurred. The patient was taken into the operating room September 1; the incision was reopened, and approximately 800 to 900 cubic centimeters of purulent urine was evacuated from the space about the kidney. The incision was left open.

Following this, the patient's course was uneventful. September 4, pyelogram disclosed that the right renal

pelvis was smaller than when the pre-operative pyelogram had been made, although some of the opaque pyelographic media had become extravasated below and lateral to the renal pelvis. Excretion of indioconimine from the right kidney was graded 3, and from the left, 4. Urine from the right kidney contained a very small amount of pus.

The patient was allowed to go directly home September 7, at which time his incision had practically healed and was not discharging urine. March 17, 1931 a questionnaire was sent to the patient, to which he replied that he had had two or three attacks of pain in the right lumbar region, but he said that it might not have been from the kidney for this pain generally accompanied a cold, and the distress did not radiate. When asked if the operation relieved his symptoms, he replied that it had. He had not been even partially incapacitated, nor had he had any further blood in the urine nor symptoms referable to the kidney or bladder. It had not been necessary for him to consult any other physician. He had had no further attacks of fever, and he felt that his condition was greatly improved. In May, 1931 he reported recovery from five days illness which followed severe exertion. A 24 hour specimen of urine at that time was normal, and pus and erythrocytes were absent. The patient was asked to return to be re-examined. October, 1931, he reported his condition as being satisfactory and there was no further evidence of renal obstruction.

SUMMARY

Indications for conservative procedures, such as resection of the renal pelvis, reimplantation of the ureter or removal of such obstructions as peripelvic connective tissue are most strikingly indicated when hydronephrosis is bilateral, and, if unilateral, when sufficient renal parenchyma remains to justify its preservation. The necessity for conservative procedures for relief of obstruction when the kidney is solitary is apparent. In making the decision as to the best conservative procedure to follow the guide is one's own expe-

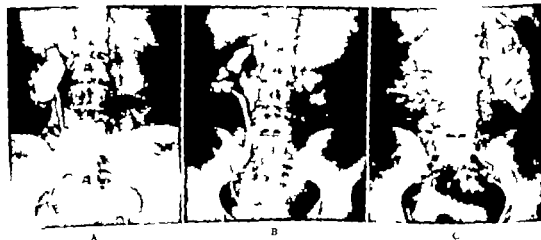


Fig. 6. A, pre-operative pyelogram of hydronephrotic right kidney. B, postoperative pyelogram of right kidney showing decrease in renal pelvis. C, pre-operative pyelogram and hydronephrotic left kidney.

rience, remembering that the safest and best procedure is the one which produces adequate and complete relief of the obstruction, with only a minimal disturbance of renal, pelvic, or ureteral tissue

Most cases of hydronephrosis are the result of definite obstruction at the ureteropelvic juncture, which in my experience, have consisted for the most part of (1) anomalous renal blood vessels, (2) peripelvic connective tissue causing angulation and collapse of the ureter, (3) narrowing of the ureter at the ureteropelvic juncture from sub-epithelial fibrosis, and (4) incomplete obstruction of the ureteropelvic juncture due to the lateral insertion of the ureter

The methods of treatment which have been used in the series of 13 cases which form the basis of this paper, have consisted of (1) division of peripelvic connective tissue which was causing angulation and collapse of the ureter, (2) removal of the ureter from its lateral insertion in the pelvis, and its reimplantation in a dependent portion, (3) its transplantation to a position away from an anomalous renal vessel that is too large to sacrifice, and (4) resection of the renal pelvis, removing the distended, enlarged pelvis in such a fashion that when resutured the ureter is made to assume a dependent position

These various operative procedures have given very satisfactory results as measured by the following effects (1) disappearance of symptoms of obstruction of the urinary tract, such as pain and fever, (2) return of the size of the renal pelvis and calyces to within normal limits, (3) absence of retention of urine in the kidney and (4) improvement in renal function as determined by

cystoscopic, pyelographic, and intravenous urographic studies made at various intervals subsequent to operation

Although there is a possibility that a dilated renal pelvis and calyces may still be draining efficiently, especially if symptoms of obstruction are lacking, yet it would seem probable that complete relief of the obstruction should be followed by their return to normal size, such as occurred in most of the cases

In 5 of the cases reported, hydronephrosis was bilateral. Two of these patients successfully underwent bilateral renal pelvic resection, one patient more than 3 years ago, and another more than a year ago. Both have been in excellent health, without evidence of obstruction of the urinary tract since operation. In the 3 other cases, operative procedures have been applied only to the kidney which gave symptoms of obstruction and which displayed the largest degree of hydronephrosis. Equally good results have been obtained in these cases. The remainder of the cases in this series are examples of unilateral hydronephrosis

Postoperative complications which are likely to occur are (1) retention of urine within the renal pelvis, which can be controlled by the temporary use of an indwelling ureteral catheter, (2) pyelonephritis, which has been controlled by intravenous administration of neoarsphenamine and mercurochrome, (3) extravasation of urine about the kidney from the line of anastomosis, and (4) the development of cortical abscesses secondary to pyelonephritis. Should the last condition develop, nephrectomy at the earliest possible moment is necessary

SYPHILIS OF THE JEJUNUM

WITH CASE REPORT

HOWARD K. TUTTLE, M.D. F.A.C.S. ANCON, CANAL ZONE

Assistant Chief of Surgery (Chief, Gynecology Division)

SYPHILIS of the gastro-intestinal tract has been described by numerous authors. In many instances this diagnosis has been based on symptomatology, X-ray examination, or histopathological study of tissue removed at operation or necropsy. Rarely have the *Treponema pallidum* been found in the lesions. McVee has been able to demonstrate the *Treponema* abundantly in an actively developing submucous gumma of the stomach and Warthin has found this organism in duodenal ulcer. Although Kaufmann refers to isolated cases of intestinal syphilis in which the *Treponema* have been found, we have been unable after careful search of the literature to find other instances in which the diagnosis has been confirmed by finding the infecting organism in the tissues. Therefore we wish to place on record the following case of syphilis of the jejunum, proved by finding the *Treponema pallidum* in the intestinal lesions.

REPORT OF CASE

E. N. Hospital Number 277,633, a colored woman, aged 34 years, native of Dominica, was admitted to Gorgas Hospital October 5, 1920, from the out-patient clinic with tentative diagnosis of tuberculous peritonitis. Her chief complaint was pain in the abdomen, feeling of heaviness,

and occasional vomiting for the past 7 months. The pain was constant and characterized by acute exacerbations of several days duration. She spoke of her belly rising at the time. She was chronically constipated. Her menses were regular and normal until the onset of her present illness, when they ceased entirely. The family history irrelevant. She has always been well with the exception of occasional headaches and fever and one normal pregnancy 3 years previous.

Physical examination showed a well developed but poorly nourished negroes with normal temperature, pulse, and respiration. Blood pressure of 120-80, head and neck negative. Lungs negative. Heart normal except for faint first sound over apex and base. The brachial arteries were bristled and there were small tortuous varicose veins on the lower side of the left thigh and leg, just above and below the knee. The abdomen was somewhat distended and rigid, and was tender on deep pressure especially in the left lower quadrant. No masses could be distinguished. There was relaxation of the vaginal outlet; the cervix showed an old laceration with some redness and a menoperian discharge. The uterus was in normal position and no masses or tenderness were in the fundus.

The urine ranged in specific gravity from 1007 to 1016, and was negative in all of seven examinations for albumin and sugar. Occasional pus cells were noted in two examinations and casts on one occasion. The leucocyte count was 6,600, neutrophils, 68 per cent; lymphoglycids, 35 per cent; blood Wassermann, strongly positive.

A gastro-intestinal X-ray film showed a moderate sized orthostatic stomach. Peristalsis was moderately active. Curvatures were negative. The pylorus was open. The cap filled and transparency was satisfactorily maintained, and was fairly satisfactory in film series. Pain was complained of on palpation. The ascending aorta was widened in suggestive degree. At 6 hours with no bowel movement the stomach was empty and the head of the barium column was at the hepatic flexure. Pain as complained of on palpation at numerous points. At 24 hours with no bowel movement the head of the barium column was in the rectum. The transverse colon presented an unusual appearance showing spasticity and much irregularity. Close examination with barium enema showed a kink in the transverse colon the nature of which as yet determined.

The patient was carefully studied for 2 weeks and appeared to have a gradually increasing intestinal obstruction of undetermined origin. The X-ray findings pointed strongly to neoplasms of the transverse colon. The positive Wassermann suggested syphilis as possible etiological factor. The question of somewhat energetic antisyphilitic treatment was raised but the impending acute intestinal obstruction made surgical intervention imperative. She continued to have increased abdominal distention with pain and vomiting, and gastric peristalsis, relieved somewhat by cathartics and enemas. Emaciation increased and her weight fell to 10 pounds.

Operation was performed on November 9, 1920, after anesthesia being used. The pre-operative diagnosis was partial obstruction of the transverse colon from malignancy. When the abdomen was opened through a high,

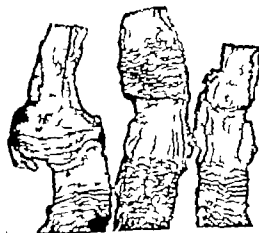


Fig. 1. Multiple anastomosing ulcers in the jejunum, showing various degrees of stenosis.

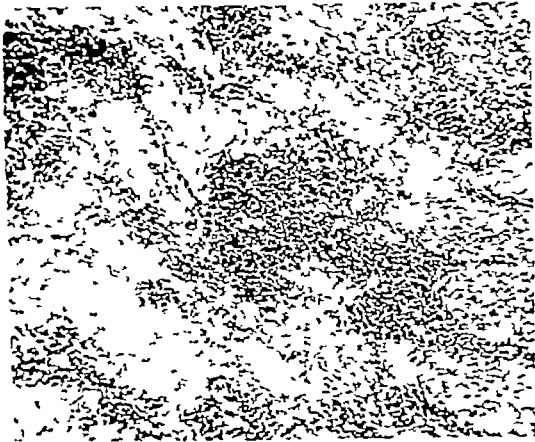


Fig 2 Submucosa and inner muscle layer showing round cell infiltration $\times 55$ Army Medical Museum No 45612

right rectus muscle splitting incision the transverse colon presented and appeared normal. Exploration disclosed a series of ten fusiform tumors of the small intestine beginning close to the ligament of Treitz and extending downward for a distance of 45 inches. The tumors were about equal distance from one another and half of them were causing nearly complete obstruction. The intervening intestine was swollen and oedematous and showed a moderate degree of inflammatory reaction. There was no ulceration of the serosa or evidence of perforation. The mesenteric glands were enlarged and firm, the largest measuring 1.5 centimeters. The gut below the distal tumor was collapsed and appeared normal. Operative procedure consisted in resection of 45 inches of the jejunum by cautery and end-to-end anastomosis by suture. The wound was closed in layers without drainage.

The convalescence was smooth with the exception of a sharp temperature reaction on the first day. She vomited once on the eighth day. The wound healed by primary union. In 2 weeks she was taking semisolid and special

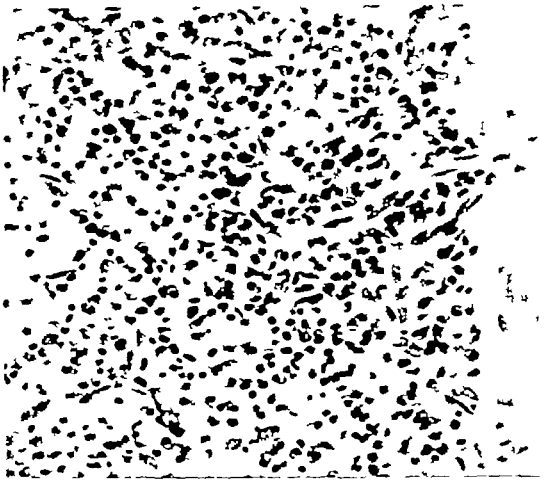
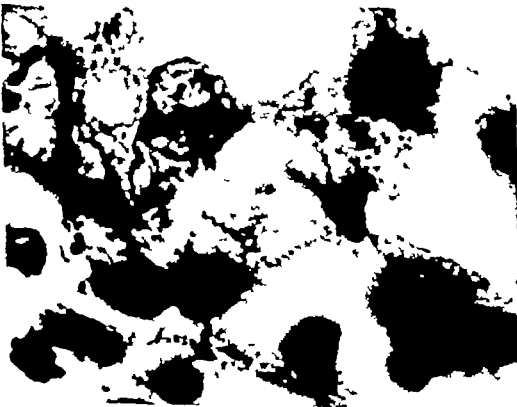


Fig 3 Plasma cell infiltration in serosa $\times 235$ Army Medical Museum No 45611

solid foods. Arsphenamine was given every fifth day and she was discharged from the hospital December 18, 1926, to continue her treatment as an out-patient. The Wassermann was strongly positive at that time.

She was seen at regular intervals in the out-patient clinic. November 20, 1927, she showed a negative Wassermann for the first time. April 1, 1930, the blood Wassermann was still negative. It is now 5 years since operation, her bowels move once or twice daily, her menstrual cycle is normal, her weight is about 170 pounds, and she is symptom free.

The specimen was examined and the following pathological reports were made: Maj P E McNabb, M C, U S A,



Figs 4 and 5 *Treponema pallidum* in cellular aggregate. Photomicrographs by Dr A S Warthin

formerly pathologist to the Board of Health Laboratory
Panama Canal Zone

Gr. description. The specimen consists of a section of small intestine 45 inches in length. The gut is heavy and boggy and slightly congested when viewed from the outside. At irregular intervals there are multiple fusiform swellings each of which measures from 4 to 7 centimeters in length. There are ten of these tumor-like lesions spaced at intervals of from 5 to 15 centimeters throughout the specimen. The lesions are firm and entirely encircle the gut. When an attempt was made to open the bowel with an incision the lesions were found constricted. Each of the fusiform tumors and several of the strictures were too small to permit the passage of the blunt blade of the finger of the nephric ring type, the width of the alteration being fairly uniform but varying in the different ulcers from 5 to 5 centimeters. The ulcer floor was clean and granular. The ulcers were extremely shallow and there was no undermining of the margins. At the ulcer site the intestinal wall measured from 1 to 5 centimeters in thickness and was firm and stiff, gradually becoming thinner and more pliable as it was followed away from the ulcer. The intestinal wall underlying the ulcer bearing area showed great thickening of the submucosa which was grayish white and opaque, and in places thin opaque gray streaks extended downward through the inner muscle coat. The outer muscle layer showed no gross lesions. The subserosa was moderately thick, gray and opaque. The serous surface was slightly roughened and in places presented small, flat, gray irregular elevations which vaguely resembled tubercles but showed no tendency to extend along the intestine.

Microscopic examination. The floor of the ulcers consisted of granulation tissue in the superficial layers of which there were many polymorphonuclear leucocytes. Underlying the ulcerated surface the submucosa was greatly thickened and richly infiltrated with lymphocytes and plasma cells. A few polymorphonuclears and eosinophils were also present. The cells lay in thick clusters about the blood and lymph vessels and also in independent aggregates between the vessels. Thin strands of these cells extended outward between the muscle bundles, and there was diffuse thickening and dense mononuclear cellular infiltration of the subserosa. The lymph vessels were dilated and contained serum and lymphocyte cells. The blood vessels generally showed no notable mural thickening. The inflammatory reaction in the submucosa extended in wedge-like manner beneath the intestinal epithelium beyond the ulcer margins and was gradually lost in the relatively normal, slightly edematous subserosa. The epithelial layer ended sometimes gradually, sometimes abruptly at the margin of the ulcers without flapping. One section showed few multinuclear giant cells. The junction of submucosa and muscularis. There lay in an aggregate of lymphoid cells and no epithelioid cells were seen. There was no tubercle formation and no areas of necrosis were found. Rarely a lymphoid cell was seen which showed a doubtful nuclear figure. The lesions were inflammatory in character and the diagnosis appeared to lie between syphilis and tuberculosis; syphilis was considered more probable.

Dr. F. B. Mallory reported as follows. The specimen showed lesions inflammatory in nature, the surfaces ulcerated, lined with granulation tissue, and along the edges were many polymorphonuclear leucocytes. The underlying tissues were infiltrated with great numbers of lymphocytes and especially with plasma cells. Eosinophilia occurred in small numbers. The inflammatory reaction is most marked in the mucosa and submucosa but is present

also in the muscle coat and in the subperitoneal tissue. The cellular infiltration in places surrounds lymph and blood vessels and in other places lies in masses between them. Many of the lymphatics are distended with serum and often contain lymphocytes in small numbers.

Dr. A. S. Warrick. The microscopic appearance of the lesions suggested syphilis very strongly but I was not so conclusively as in a case of syphilitic intestinal ulcer that I have observed. Nevertheless, we succeeded in demonstrating numbers of *Spirochetes* in this tissue, so there could be no doubt that it was syphilitic ulcer of the duodenum.

We found *Spirochetes* in all parts of the intestinal wall, but particularly just below the border of the ulcer grouped around the blood vessels and along the blood vessels extending into the wall. They were so numerous that I found 50 to 100 in a single section, but they usually lay singly and only occasionally in small groups. They were all stained with the Warthin-Starry silver stain method and we had no difficulty in finding them in this material.

Dr. James Zwarg believed that the lesions probably was an infectious granuloma, chiefly on the basis of the predominant plasma cells, and not neoplasia.

REVIEW OF THE LITERATURE

Kanner says that syphilis of the intestines may be either congenital or acquired. The congenital lesions are usually in association with lesions of other viscera, such as the lung, the liver, etc. The most definite lesion in the intestine, namely small fistulae or multiple gumma-like processes occur in the ileum although they are found elsewhere. These may undergo ulceration as is true of the acquired lesions. They affect particularly the rectum, the sigmoid, and other decurves as well as other parts of the colon, but are rarely observed in the small intestine.

Garwood and Kolodny describe two forms of intestinal lesions in acquired syphilis: (1) an early acute catarrhal enteritis, occurring as part of the secondary eruptions, general visceral rosolia, with the symptoms of any acute catarrhal enteritis; (2) late involvement or tertiary lesions with symptoms usually like those of other forms of acute enterocolitis. The microscopic proof of the diagnosis by finding the Treponema in the tissues is practically impossible. Regarding this, they quote Eimerman as follows: "After all, there is no decisive, ultimate diagnosis because, at the present time, (1931) *Spirochetes* have not been demonstrated in the tissues and we know that histopathological criteria are not conclusive. They continue by describing the pathological probabilities found in the lesions and conclude that only those cases of syphilis of the stomach and intestine which have been diagnosed histopathologically are absolutely convincing."

MacCallum says that tertiary lesions of the small intestine are usually localized in the jejunum, or in the upper ileum, where they appear as flat elevations of the character of syphilitic granulation tissue in oblique submucosa and mucosa. Multiple ulcers are found which extend round the gut, and which in healing may produce strictures. There is a remarkable example of this in the Pathological Museum of Columbia University but the condition must be very rare.

Cheyne and Burghard observe that syphilitic strictures occur both in hereditary and acquired syphilis, most commonly in the upper part of the small intestine but also lower down and occasionally in the colon. They are generally multiple and surround the intestine like tuberculous ulcers. With the exception of the catarrhal enteritis in the secondary stage the diagnosis of syphilitic ulceration of the intestine is extremely difficult and often impossible.

The symptoms closely resemble those of tuberculous ulceration of the intestine and if they occur in a patient beyond 35 years of age, are associated with other syphilitic lesions, the Wassermann reaction is positive, and, further, if they have existed for a considerable time and no definite symptoms of any other condition, such as malignancy or tuberculous disease are present, syphilis may be suspected.

Stokes classes syphilis of the intestine as a rarity of the first order, and a clinical incognita. He states that clinical study of diseases of the lower intestinal tract discloses so many conditions, such as endemic amebiasis and idiopathic chronic ulcerative colitis, the influence of which in intestinal pathology is not yet appreciated, that one is compelled to distrust the older statistical estimates, and the mere coincidence of intestinal disease with systemic syphilis.

Kaufmann describes the lesions of congenital and acquired syphilis of the intestine and states that *sprochæta* have been found in isolated cases (Warstedt, lit.).

Wile quotes Frankel, who, in an analysis of 10,000 post-mortem examinations covering 10 years, found only 3 cases of genuine intestinal syphilis. Oberndorfer, quoted by the same author, has collected only 24 cases of authentic intestinal syphilis. Wile believes that late involvement is more common than early involvement. Occasionally recognized at the bedside, it is more frequently found at autopsy or operation.

Elder reports a case with tertiary ulcer on the eyelid, which developed acute abdominal symptoms. Operation revealed an obstruction $2\frac{1}{2}$ feet above the ileocaecal valve, with a firm nodular mass in the lumen of the bowel and enclosed in a mass of omentum. When resected the ulcer of the intestine presented syphilitic characteristics and microscopically an endarteritis.

Gutman mentions a case which at autopsy revealed the presence of about 15 ulcers spread throughout the small intestine with constriction resulting in the majority. There was no evidence of tuberculosis on either gross or microscopic examination.

Rosenfeld reports a case of stenosis of the small intestine of syphilitic origin. Examination of the specimen removed showed the condition to be syphilitic.

Riggs reports a case of jejunal ulcer with resection of 8 inches of intestine and end-to-end anastomosis. The upper mesentery contained a mass of soft glands that on microscopic examination showed only lymphoid hyperplasia.

Upcott-Gill and Jones observed a case, assumed to be early gumma occurring in the terminal ileum. Two feet of ileum was resected and lateral anastomosis done. No record was noted of pathological report of tissues. There was recurrence 7 years later with secondary operation at which a segment of intestine in the terminal ileum was thickened and injected and accompanied by enlarged mesenteric glands. The abdomen was closed without interference with the intestinal tract, and the patient was put on antiluetic treatment. Diagnosis was made by eliminating tuberculosis, the dysenteries, and new-growth.

Simon quotes a case reported by Howers. A man, age 23, who gave a distinct luetic history, complained of a persistent diarrhoea with bloody stools, abdominal pain, and distention aggravated at night. The patient subsequently died of an influenza pneumonia and at autopsy circular constrictions were found in the bowel as the result of cicatrized ulcerations.

Anderson and MacEwen report a case of generalized syphilis, with stricture of the small intestine causing intestinal obstruction and resulting in death. Postmortem examination revealed, in addition to the constricted ulcer, a great infiltration of mesenteric glands and retroperitoneal tissues and masses in the liver and the upper pole of the left

kidney. Microscopic examination showed the thick walls of the strictured intestine and these masses to be gummatous.

Wahlberg describes a case coming to operation for acute perforation of two ulcers of the jejunum near the insertion into the mesentery, 20 centimeters below the duodeno-jejunal flexure. There was infiltration without stenosis or scars. Diagnosis of syphilis was made only after microscopic examination.

Schmidt reviews the literature of acquired syphilis of the small intestine and adds a personal case. A tumor of the lower duodenum, removed by resection, and diagnosed by microscopic examination.

Hinz has collected a total of 39 cases of syphilitic stricture of the small intestine from the literature, 10 in the jejunum and ileum, 8 in the jejunum, 7 in the colon, 6 in the ileum, 2 in both small and large intestines, 2 in the ileocaecal region, 1 in the juncture of the duodenum and jejunum, and 3 unnamed. To these he adds a personal case.

Perry reports a jejunal stricture with intestinal obstruction—operation, lateral anastomosis. Postmortem diagnosis was syphilis. Postmortem Wassermann reaction was positive.

Trabucco adds a case report to the literature. A man, 43 years, with a history of fever followed by chronic diarrhoea, colic, pain before meals and sometimes after, and vomiting for a year. Wassermann reaction was 4 plus. Operative findings consisted of annular stenosis of the duodenum and four similar strictures in the next 40 centimeters of intestine. A fifth at 1 meter from the duodenum. Enterostomy was done. Later syphilitic treatment was given and patient recovered.

Nishikawa, among several cases of intestinal syphilis, reports 4 occurring in the small intestine, as observed at the Pathologic Institute of Rud. Virchow Hospital, Berlin.

De la Guardia has recently reported a case which at operation revealed an indurated, irregularly outlined ulcer about 3 inches in length, involving almost the whole circumference of the intestine and affecting the terminal end of the duodenum and the first part of the jejunum. This had caused an almost complete obstruction with marked dilatation of the stomach. The diseased portion of the intestine was resected and an end-to-end anastomosis was performed. The histopathological diagnosis of syphilis was made by Dr. F. B. Mallory of Boston.

SUMMARY AND CONCLUSIONS

From this review of the literature we believe that lesions of syphilis may be found in the small intestine with early secondary or late tertiary manifestations. In view of the early glandular involvement, it would seem that the numerous lymph follicles of the intestine could scarcely escape infection, with resulting symptoms of irritation. Intestinal involvement in the secondary stage is probably more frequent than is recognized, but as these cases undoubtedly improve immediately under early treatment, leaving little evidence of the infection, an accurate pathological diagnosis is extremely difficult as few cases are operated upon or die during this stage of the disease. For this reason late lesions with gumma formation followed by ulceration, cicatrization, and intestinal obstruction are more often re-

ported in the literature of intestinal syphilis, and because of this course. In most cases the condition is discovered at operation or necropsy.

The symptoms of late intestinal syphilis are those of chronic ulceration with diarrhoea, and pus and blood in the stools. As stricture formation progresses, tumors may become palpable colic like pains result from increased narrowing of the bowel, and as further contraction takes place the picture becomes identical with a gradually increasing intestinal obstruction.

The condition must be differentiated from tuberculosis, malignancy including primary and metastatic carcinoma and lymphoblastoma, actinomycosis, intestinal amoebiasis, bacillary dysentery and ulcers resulting from acute enteritis. In the gross, syphilis of the intestine may greatly resemble tuberculosis. Brown and Sampson describe tuberculous strictures of the intestine as follows: "A stricture following a girdle ulcer may be annular and single, or as in Holmeister's case, multiple, for he found 10 ring strictures in 2.5 meters of bowel. Thirteen of his 83 cases were multiple." Lewis reports a case of multiple intestinal ulcerations and constrictions that on histopathological study seemed typical of syphilis. However the autopsy revealed tuberculosis of the lungs and pleura. These latter findings, in the absence of either the *Treponema pallidum* or tubercle bacilli in the tissue certainly leaves the diagnosis open to doubt.

Lymphoblastoma may be equally difficult to differentiate in the gross. Sections from this case were submitted to several expert pathologists, two of whom considered the condition as lymphoblastoma.

We believe that the diagnosis of intestinal syphilis cannot be made with any degree of certainty short of accurate histopathological study and that an absolute diagnosis must rest on the finding of the *Treponema* in the tissues. We feel that more refined staining technique and long search will yield positive results in certain of these cases and agree with Stokes that it is from the field of tuberculosis of the bowel, inadequately investigated for syphilis, and called tuberculosis merely on the basis of surgical and pathological findings, the future clinical syphilis of the intestine may be recruited.

Most cases of late syphilis of the intestine will be referred to the surgeon because of an impending obstruction. The treatment will be that of intestinal obstruction. Antiluetic treatment alone will not suffice. While the ulcerations will undoubtedly heal under medical agents, the resulting cicatrization will eventually lead to obstruction of

the bowel. Surgery must be followed by active antiluetic medication to prevent recurrences and close observation of the patient continued over a period of years.

The original segment of intestine removed in this case is now at the Army Medical Museum.

The author desires to thank the various pathologists who have contributed their opinions; Major Gen. R. Callesse, curator of the Army Medical Museum, for photographs of the gross and microscopic appearance of the tissue; and Col. P. M. Ashburn, Librarian, Army Medical Library for his aid in obtaining abstracts. I feel especially indebted to the late Dr. A. S. Warthin for his stained sections and photomicrographs showing the treponemal pellicle.

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EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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OCTOBER, 1932

THE ACCELERATION OF CIRCULATION BY OPERATIVE MEASURES

FROM the dawn of surgical practice, operators have striven to control the circulation of the blood. Hæmorrhage, the fear of the primitive surgeon, remains for many operators the most dangerous operative complication. Surgical progress has ever followed improvement in hæmostasis. The mark of the skilled surgeon lies in his control of hæmorrhage. In recent years, for example, with the introduction of electrical methods for the bloodless division of tissues, we find Cushing recalling patients having types of vascular tumors of the brain that formerly he had abandoned as inoperable. And with improved vascular control, even the general mortality for operations upon the brain has markedly fallen. For centuries surgeons have been so beset by the difficulties in stopping bleeding, of slowing and arresting the circulation, that little thought has been given methods that hasten the flow of blood through the vessels. Indeed, to suggest an operation to speed the flow of blood would have seemed a

gruesome jest. We slow or arrest the blood current by ligatures, bands, coagulants, wiring, or restore a normal circulation by vascular suture, or by dilating contracted vessels through division of the sympathetic nerve supply, but operation to speed the blood through undilated vessels is a new problem which now is presented for consideration.

By sufficiently accelerating the flow of blood, a small or narrowed vessel may function as one of greater diameter, a stenosed channel or opening may be made competent, a regurgitation of blood antidoted, a vascular leak overcome. Thus, a means suggests itself for relief from the chronic invalidism of a stenotic mitral valve or a congenital narrowing of the pulmonary artery. But other possible benefits crowd for consideration. By speeding the blood through chronic inflammatory areas as those of tuberculosis, beneficial tissue reactions may be stimulated. Although increased vascular flow renders the vessel more efficient, it causes an amazing reduction in the strain to which the wall of the vessel is subjected. This is a paradox known to all hydraulic engineers, for the wall pressure sustained by a blood vessel is inversely as the rate of flow of the liquid through the vessel. Slow the current through an artery, or an aneurism, and the wall or bursting pressure increases. Hasten the flow of blood through an aneurism and the pressure upon the sac falls, the bursting effect is negated, the sac tends to collapse, and pressure upon adjacent structures is relieved. Since 1925, when the first operation of this type gave a patient with a large thoracic aneurism relief from intense pain and ability

to resume work nearly 50 operations of this character have been done for thoracic aneurism—with evidence that it is the most efficient measure yet devised for inaccessible aneurisms. By speeding the blood through the aorta the systolic pressure falls, anginal pains also may be relieved and an incapacitated hypertensive patient may be able to resume work. One patient who had been confined to bed for 18 months by an effort angina has been doing his routine work completely relieved for the 2 years since the operation.

How may the circulation be speeded? Obviously by increasing the output of the heart or by diminishing or eliminating peripheral resistance. Practically by turning the arterial blood with its high pressure into a vein of low or negative pressure, both ends may be attained. With the drop in resistance the velocity of the blood in the artery increases. By the more rapid return of blood, the heart fills in shorter time, and the efficiency of this organ, which according to its well known law depends upon the filling of the auricles, is increased. To be effective, the blood must pass in the direction of the normal venous current and not across or against it. An end-to-end anastomosis in the direction of vascular flow is essential. A lateral or side-to-side anastomosis interferes with the venous circulation and is harmful. The type of operation thus far used has consisted of the division of the common carotid artery and deep jugular vein in the neck and an end-to-end anastomosis of the cardiac ends of the vessels, the peripheral ends being ligated. As the blood from the carotid with its high pressure and velocity enters the vein with its sluggish low pressure flow the vein partially collapses from the reduced wall pressure that is associated with increased velocity. The mixed blood speeds through the descending vena cava and right heart to the lungs. The output of the

heart and the pulmonary circulation are increased yet a great fall in the general systolic pressure has been produced. The heart may beat slower yet its output is increased. The respiratory rate also may fall from the double oxygenation of a part of the blood in the lungs. In a patient with pulmonary tuberculosis the average reduction was 10 respirations a minute after the operation a saving of over 14,000 inspirations and expirations every 24 hours.

A modification of this type of operation offers a more effective method of treating the dangerous intracranial aneurisms which, after a period of temporary improvement following the ligation of the internal artery tend to increase in size and cause death. By anastomosing the cephalic end of the common carotid or internal carotid on the side of the aneurism with the cardiac end of the deep jugular vein, the possibility of producing such a leak of blood from the aneurism as to lead to collapse of the sac is apparent.

These anastomotic operations which increase the flow of arterial blood with a reduction in systolic pressure may be done with a low mortality and apparently without the same danger of cerebral degeneration of a simple ligation of the common carotid. They seem to deserve further trial in treatment of inaccessible aneurisms, malignant hypertension, stenotic lesions of the heart and great vessels and perhaps other conditions in which the effects of increase in arterial flow are desirable.

W. WAYNE BASCOCK.

CANCER RESEARCH IN THE ARGENTINE

WHILE in Buenos Aires recently the writer visited the Institute of Experimental Medicine for the Study and Treatment of Cancer which is maintained by the government and is one of the

best equipped and most active of its kind in the world. In its cheerful little hospital of one hundred beds and its out patient department, aided by excellent laboratories and an adequate equipment for the use of X-rays and radium, have been treated and studied some 39,000 cases of malignant growths during the past 10 years. The institution is conducted by Dr. A. H. Roffo, an enthusiastic and thoroughly scientific investigator, whose voluminous writings have appeared almost exclusively in the Spanish, German, and other foreign journals, and hence apparently have failed in this country to attract the attention they deserve.

Dr. Roffo, like most but not all investigators, does not believe in the parasitic origin of malignant growths, but regards them as a manifestation of abnormal local cell activity. He asserts that normally cells receive nourishment by osmosis through their membranes, the permeability of which is regulated by the amount of cholesterol in the system and especially in the adjacent tissues—too much cholesterol leads to too much cell growth and this may lead to cancer. The proper amount of cholesterol is maintained by certain organs and varies in different parts of the body and under different conditions. For instance, in the embryo and in the growing individual it is greater than in the adult, the skin of the face as a whole contains three or four times as much as that of the abdomen, while the nose has 73 per cent more than the forehead. This distribution of cholesterol corresponds strikingly with the fact that 98 per cent of skin cancers occur on the face, and that the nose is the most frequent seat.

From these and many other considerations, Dr. Roffo believes that cancer (used in its broader sense to include all types of malignancies and lesions) is intimately associated with cholesterol, and he seems to have been able to demonstrate experimentally and by clinical

observation that a superabundance exists not only in the tumors themselves and their surrounding tissues, but also in the so called precancerous conditions. Although his extensive studies are not yet complete, he hopes to be able to evolve from them a method for determining the susceptibility of individuals to cancer and perhaps a means of diagnosing its presence.

An interesting fact derived from his investigations is that the amount of cholesterol in the skin is greatly increased by exposure to ultraviolet rays, which he thinks accounts for the superabundance of that substance and the greater frequency of cutaneous cancer in the exposed regions of the body, such as the face. He thinks it is especially significant that the upper part of the forehead, where it is protected by the hat and the hair, is relatively exempt.

Another interesting observation is that the X-ray and radium, when used locally and in proper dosage, have a marked tendency to diminish the amount of cholesterol in the tissues, and this, he thinks, explains their curative effect. He also accounts for the *malaise*, so frequently following excessive radiation, by the consequent diminution of cholesterol in the system resulting in slowing up of cell metabolism. With this also is combined a disturbance of the vegetative nervous system, which requires a certain balance of the lipoids for its proper activities.

Another allied line of research has led to the study of chlorophyll, the coloring matter of plants, which protects them from the actinic rays of the sun. The pigmentation of the skin in man serves a similar purpose and may help to explain the comparative absence of cutaneous cancer in the colored races. Dr. Roffo is experimenting with chlorophyll to see if it can be utilized in some way to reduce the superabundance of cholesterol in the tissues of

those predisposed to, or already affected with, cancer

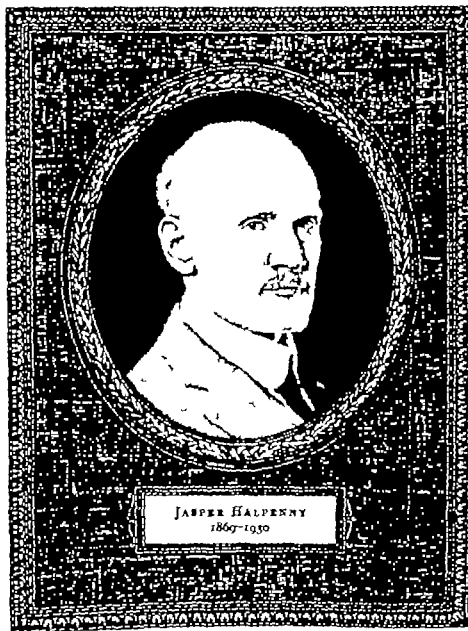
If one accepts Dr. Roffo's theory it follows that one should be able to prevent the occurrence of cancer in predisposed individuals or perhaps effect its cure when already present, by reducing the amount of cholesterol in the system through appropriate feeding. He has done this in animals, a number of white rats being divided into two groups, one of which was fed on a fatty diet, while the other was deprived of fats entirely. Both groups were then inoculated with malignant tumors, which failed to develop in the fat free series, but

invariably did so in the others. If a tumor was already present it often disappeared.

Although it is dangerous to reason from animals to man nevertheless such an experiment is sufficiently suggestive to warrant the trial of the method in humans, which Dr. Roffo is at present doing, with what he regards as encouraging results.

Whether one agrees with Dr. Roffo or not, and many will remain unconvinced, it must be acknowledged that he is doing earnest and scientific work which may lead to a welcome increase in our none too great knowledge of malignancy.

LEONARD FREEMAN



MASTER SURGEONS OF AMERICA

JASPER HALPENNY

IN recording the death of Doctor Jasper Halpenny one more name is added to the distinguished list of surgeons and great medical teachers who have passed on. His death on December 19, 1930, was a great loss to Canadian medicine but particularly to the medical school and medical fraternity of Manitoba.

Doctor Halpenny was born in Listowel, Ontario, October 23, 1869, the son of Richard and Elizabeth Halpenny. He moved with his parents to the Province of Manitoba in 1880. He taught school in Manitoba in 1889-1891. He attended Manitoba University graduating in Arts and later received the degree of M A. He took his medical course in Manitoba Medical College, and in 1900 Manitoba University conferred upon him the degrees of M D and C M.

For four years following graduation he was medical superintendent of the Winnipeg General Hospital. He was then appointed to the teaching staff of the department of surgery of the medical faculty of the University of Manitoba and continued actively in this capacity. In 1919, he was appointed professor of surgery and director of the department of surgery, a position he filled with great distinction until his voluntary retirement on account of ill health in 1927. During all these years he carried on a very busy practice in general surgery in the city of Winnipeg and for many years was chief of surgery in the Winnipeg General Hospital.

Doctor Halpenny was keenly interested in medical research, particularly in surgical problems, leading the way for his students and confrères. He was never so happy as when working with his internes on clinical problems and his untiring energy and enthusiasm was always a great stimulus to them. He was responsible for the establishment of an experimental laboratory in the Medical College where, under his wise guidance, many young surgeons had an opportunity to do surgical work on dogs.

In 1909, he was appointed government delegate to the International Medical Congress in Budapest, Austria, where he read an exhaustive paper on "The Symptoms, Pathology and Treatment of Typhoid Spine." On that occasion he was presented at the Austrian Court.

Doctor Halpenny's activities were not confined to medicine alone. He took a very active interest in the social and public welfare of the community and for many years was a member of the Industrial Bureau of Winnipeg. He took a keen interest and was partly responsible for the establishment of periodic medical examinations of the school children of the public schools of the city of Winnipeg. He is joint author with his wife of *How to be Healthy* a book which is still used in the public schools of this province as the text in teaching hygiene.

In addition to his hospital and teaching appointments, he from time to time held many important offices such as president of the Manitoba Medical Association, president of the Winnipeg Medical Society member of the University Council of Manitoba, member of the Council of the Faculty of Medicine. He was one of the founders of the American College of Surgeons, and for a time served on the Board of Regents of the College and was later appointed vice president.

In religion he was a Methodist, independent in politics, a member of the Masonic Fraternity in all of which he took an active interest.

One might eulogize at length his personal characteristics which were those of a man of firm convictions and boundless energy which was applied chiefly to his professional work, particularly medical teaching. The students always came first and he was their loyal friend.

He married Lillian Brown Ireland who was responsible for his happy domestic life. She with three sons remain to mourn his death. GORDON S. FAHRELL.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE second half of the sixth volume of Veit's *Handbuch der Gynäkologie*¹ covers the clinical aspects of uterine tumors, being therefore a companion volume to the first half of volume vi which dealt with the laboratory and microscopic studies of uterine neoplasms. Peham has written the section on myomata exclusive of radiation therapy, Esch has written the same for sarcomata, the sections on the radiation therapy of both types of tumors being done by Martius. These sections are all complete, well illustrated, and contain careful compilations of the world's statistics.

The section on the treatment of carcinoma of the uterus is 400 pages long and is probably the most complete text on the subject available today. It is written by Pankow who has gathered together all the world literature on both the operative and the radiation therapy. The portion dealing with the operative form of therapy contains a detailed description of each accepted type of operation, together with a comparison of all of the published statistics, there are also splendid illustrations of each type of operation, many of which are in color.

The section on radiation therapy is most noteworthy. Here is described every recognized type of radiation therapy the world over together with a comparison of published statistics and of the end-results obtained. A most complete and extensive bibliography of the world literature makes this volume a complete reference work of the subject of therapy of carcinoma of the uterus. To the clinician, the research worker, and the radiologist this work will stand out as the most usable and most complete work on the subject of carcinoma of the uterus. It must therefore be highly recommended.

RALPH A. REIS

THE author, James G. Poe, a teacher of anæsthetics for 16 years, has compiled a didactic manual² on general anæsthesia for the use of medical and dental students, internes, and general practitioners. The chapters cover the usual range of subjects discussed in the more comprehensive books on anæsthetics. Explicit directions are given for the administration of the different anæsthetic agents,

and the signs of anæsthesia are graphically charted. A chapter is devoted to the non-volatile anæsthetics—ætherin, sodium amytal, and pernocton. The final chapter is given to local anæsthesia including spinal anæsthesia. The typographical appearance and the general makeup of the volume is a credit to the publishers.

ISABELLA C. HERB

AT the time of his death Dr. Knox was engaged in the preparation of a new edition of his textbook³. The sections dealing with X-ray therapy were in a fairly advanced stage of preparation. The subject matter of some of the chapters had been exhaustively dealt with by Dr. Knox, but in others the revision had not reached an advanced stage and in some there were complete gaps in the work. By collaboration with Dr. N. S. Finzi and the help of Mrs. Knox (Alice Vance Knox, M.B., B.Ch.), Dr. Levitt has edited the finished chapters, supplied the missing portions of the uncompleted ones, and supplied new chapters to round out the work into a very commendable and reliable textbook on X-ray therapeutics. The balance has been held between the claims of the more conservative therapists and the intensive methods of what might be called the newer school.

The work, therefore, represents a very fair estimate of the present field of X-ray therapy, not only for malignant disease, but for the numerous non-malignant diseases in which roentgen therapy is indicated. There are chapters on carcinoma and sarcoma in general, then chapters on diseases of the various systems, skin, blood, lymphatics, chest, digestive tract, urogenital tract, diseases of the pelvic organs in the female, nervous diseases, thyroid and thymus affections, and diseases of the bones and joints. In the Appendix, a chapter is devoted to the recommendations of the international committee concerning roentgen therapy.

As should be the case in a textbook of this kind, about half of the work is devoted to technical and physical considerations, particularly those relating to the possibility of accurately measuring the incident dosage and the depth dosage delivered to the parts under treatment. The international *r* unit has been adopted, and carefully correlated with the unit skin dose, which at the time of Dr. Knox's death was the accepted unit of dose measurement. The *r* unit

¹ VEIT'S HANDBUCH DER GYNÄKOLOGIE. Edited by Dr. W. Stoeckel vol. vi, 2d half—DIE KLINIK DER UTERUS-TUMOREN. Edited by P. Esch, H. Martius, O. Pankow, H. v. Peham, L. Schönholz. Munich J. F. Bergmann, 1931.

² MODERN GENERAL ANÆSTHESIA. A PRACTICAL HANDBOOK. By James G. Poe, M.D. 2d ed. rev. and enl. Philadelphia: F. A. Davis Company, 1932.

³ A TEXTBOOK OF X-RAY THERAPEUTICS. By (the late) Robert Knox M.D., C.M. (Edin.) M.R.C.S. (Eng.) L.R.C.P. (Lond.), M.I.E.E., D.M.R.E. Completed and edited by Walter M. Levitt, M.B. (Ire.) M.R.C.P. (Lond.) D.M.R.E. (Camb.) New York: The Macmillan Company, 1932.

relates to physical measurement, whereas the unit skin dose is a measurement of the biological effect. Much evidence of a biological character supports the view that the same dose in r of different wave lengths does produce the same biological effects, the wave length range being even quoted as wide as from the Grenz rays to the γ rays of radium. The time factor or time spacing of the radiations, is very important, and renders the problem much more complicated. In fact, a statement of dosage,

without an accurate record of the time spacing of the treatments, is almost worthless.

The work is a valuable one, and has the advantage that it is in English, available to American radiologists at once, most of the books hitherto published being in a foreign tongue. There is and need for wide dissemination of the knowledge of properly administered and measured deep therapy for it is a fact that a great deal of bit and miss X-ray treatment is being given in this country. JAMES T. CARL.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

THE SIGN OF BARKER: A STUDY OF THE EVOLUTION OF CORTICAL DOMINANCE IN PRIMATES. By John F. Fulton and Allen D. Keller. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1932.

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CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

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CLINICAL CONGRESS PROGRAM IN BRIEF

SESSIONS AT JEFFERSON HOTEL EXCEPT AS NOTED

Monday, October 7

- 9:30 Hospital conference
- 10:00 Clinics in hospitals
- 10:30 Hospital conference
- 11:00 Surgical film exhibition—Statler Hotel
- 8:55 Presidential meeting

Tuesday, October 8

- 9:00 Clinics in hospitals
- 9:30 Hospital conference—Tuttle Memorial Auditorium
- 10:00 Surgical film exhibition—Statler Hotel
- 10:30 Clinics in hospitals
- 11:00 Hospital conference—Tuttle Memorial Auditorium
- 11:30 Surgical film exhibition—Statler Hotel
- 12:00 Hospital conference—Tuttle Memorial Auditorium
- 8:00 Scientific session, general surgery
- 8:15 Section on ophthalmology—Statler Hotel

Wednesday, October 9

- 9:00 Clinics in hospitals
- 9:30 Hospital conference—Tuttle Memorial Auditorium
- 10:00 Surgical film exhibition—Statler Hotel
- 10:30 State and provincial executive committee
- 11:00 Clinics in hospitals
- 11:30 Hospital conference—Tuttle Memorial Auditorium
- 12:00 Surgical film exhibition—Statler Hotel

- 10:00 Symposium—Treatment of Fractures
- 8:00 Community Health Meeting—St. Louis University
- 8:55 Symposium
- 8:55 Scientific session, general surgery

Thursday, October 10

- 9:00 Clinics in hospitals
- 9:30 Hospital conference—Jewish Hospital
- 10:00 Surgical film exhibition—Statler Hotel
- 10:30 Annual meeting of College
- 11:00 Symposium—Cancer is Curable
- 11:30 Clinics in hospitals
- 12:00 Hospital Conference—St. Mary's Hospital
- 8:55 Scientific session, general surgery
- 8:55 Section on otolaryngology—Statler Hotel

Friday, October 11

- 9:00 Clinics in hospitals
- 9:30 Surgical film exhibition—Statler Hotel
- 10:00 Meeting of new Fellows, class of 1912
- 10:30 Clinics in hospitals
- 11:00 Surgical film exhibition—Statler Hotel
- 11:30 Conference on industrial medicine and trademark surgery
- 8:55 Convocation

AMERICAN COLLEGE OF SURGEONS

PRELIMINARY PROGRAM FOR THE ST LOUIS CLINICAL CONGRESS

FRANKLIN H MARTIN, M D, Director-General

GREETINGS FROM THE PRESIDENT

ALLEN B KANAVEL, M D, CHICAGO

WHEN Lindbergh named his airship "The Spirit of St. Louis" it was more than a polite gesture. St. Louis has never been the great Northwest and Southwest by right of discovery and conquest. Her Papins, Chateaus, Ashleys, and other fur traders dominated the Northwest. She was the commercial center for Westport Landing and the Santa Fe Trail. From here Lewis and Clark started to Oregon and the Pacific, and Pike to Colorado. Here Beaumont finished his classical observations on Alexis St. Martin, and visiting surgeons will find much of his work and that of other early St. Louis physicians in the medical museum.

Dominated by this pioneer energy and ability, the descendants of these empire builders have not been content with less than the best in civic affairs. Their hospitals and medical schools have kept step with the advances in medical education. St. Louis is the center to which physicians of the Southwest look for their clinical and post-graduate instruction. Unfortunately the through continental trains to New York, Chicago, Rochester, and San Francisco have turned the tide of travel to these cities, and the physicians of the West, North, and South have not appreciated at their true value the clinical facilities of St. Louis. It is a great pleasure to the American College of Surgeons to offer these to its members from all parts of the United States and Canada.

Evarts A. Graham, professor of surgery of Washington University School of Medicine, with a committee representing all the medical schools and hospitals, has prepared an extensive program presenting their clinical material, much of it unique in nature. Here will be found some types of surgical work not to be seen elsewhere in the United States.

One word more. St. Louis is close enough to the old South to have retained, with its pioneer spirit, the charm and good will of southern courtesy, so that our members may be certain of a warm professional hospitality.

NEVER has interest in the American College of Surgeons been keener than in this year of depression. Never has greater industry been manifested on the part of a Committee on Arrangements than that shown by the St. Louis group, under the chairmanship of Dr. Evarts A. Graham. Never has more genuine enthusiasm been demonstrated by medical schools and hospitals of a city in their preparation of a clinical program that will be of interest and benefit to their guests. The organized medical societies and the independent practitioners of St. Louis, as well as the entire medical profession of the state of Missouri, have exerted their best efforts in behalf of the Clinical Congress of the American College of Surgeons. Hence our Board of Regents congratulates itself that St. Louis was selected as the meeting place for 1932.

It is gratifying that the volunteer applications for Fellowship this year, when the economic conditions are abnormal, are exceeding the usual rate, that the work of our Credentials Committees is being carried on even more judiciously, and with greater zeal, that the prospects for a normal group of fit applicants is so genuinely encouraging.

OPERATIVE CLINICS AND DEMONSTRATIONS

Operative clinics and demonstrations will be conducted by the medical departments of Washington University and St. Louis University, and in twenty-six approved hospitals of St. Louis.

It will be noted that clinics are scheduled for the afternoon of Monday, beginning at 2 o'clock, and for the mornings and afternoons of each of the four following days, and that the program includes operative clinics and demonstrations in all branches of surgery—general surgery, gynecology, obstetrics, orthopedics, urology, proctology, ophthalmology, otolaryngology, etc.

The clinical program as published at this time is merely an outline or basis for the final program, as during the Congress the clinical program will be published daily in the form of bulletins prominently displayed on large bulletin boards at headquarters at the Jefferson Hotel. These bulletins will be posted each afternoon showing in

SURGERY GYNECOLOGY AND OBSTETRICS

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complete detail the clinics to be given on the following day. The same material will be published in the *Daily Bulletin* for distribution to the visiting surgeons early each morning.

The clinical program presented by the St. Louis surgeons will provide many special features including (1) demonstrations of modern methods in the treatment of fractures at several of the hospitals where plans have been made for a comprehensive showing of the methods used and the results obtained in the treatment of surgical work in which forms so large a part of surgical work in large cities and industrial centers (2) demonstrations of the treatment of cancer by surgery, radium and X-ray (3) rehabilitation in industrial and physical therapy of patients injured in industrial and automobile accidents, etc (4) surgical research and experiment

EVENING MEETINGS

The Executive Committee of the Clinical Congress has prepared programs for a series of five evening meetings as presented in the following pages. At the presidential meeting on Monday evening in the ballroom of the Jefferson Hotel following the introduction of distinguished guests, the president-elect, Dr. J. Bentley Squier of New York will be inaugurated and deliver the annual address. This will be followed by the annual John B. Murphy oration in surgery delivered by Sir William I. de Courcy Wheeler of Dublin, Ireland.

On Tuesday, Wednesday and Thursday evenings at meetings in the ballroom of the Jefferson Hotel papers on various surgical subjects of present-day interest will be presented and discussed by a number of eminent surgeons of the United States, Canada, and England.

Two special orations are included in the program (1) the annual oration on fractures by Dr. Philip D. Wilson, of Harvard Medical School and the Massachusetts General Hospital (2) an oration by Dr. Frederic A. Boley, chairman of the Board on Industrial Medicine and Traumatic Surgery dealing with the present and future activities of this department of the College work. Two meetings of special interest to ophthalmologists and otiolaryngologists will be held in the ballroom of the Statler Hotel on Tuesday and Thursday evenings at which men of outstanding experience in these specialties will present papers.

CONVOCATION

At the annual Convocation on Friday evening the Initiates of 1934 will be presented by the

Board of Regents for Fellowship in the College. Other interesting features of this session will be the conferring of Honorary Fellowships, the Convocation address by the Incoming president, Dr. J. Bentley Squier, of Columbia University and the Fellowship address by Dr. Robert A. McKean, director of the Norman Bridge Laboratory of Physics, and chairman of the Executive Council of the California Institute of Technology at Pasadena.

GUESTS FROM FOREIGN COUNTRIES

Among the distinguished visitors from abroad who will attend the Clinical Congress and participate in its activities are Sir William I. de Courcy Wheeler, past president of the Royal College of Surgeons of Ireland, Sir George Lenthall Cheate, consulting surgeon, King's College Hospital, London. Dr. José Goyanes, professor of surgery in the National Academy of Medicine of Madrid, Spain, and president of the Society of Surgeons of Madrid.

SYMPOSIUM—CANCER IS CURABLE

A special feature—of great interest to all cancer experts, and the public as well—will be a symposium on the curability of cancer, to be held in the ballroom of the Jefferson Hotel at 3:30 o'clock, Thursday afternoon. This will be participated in by a group of clinicians who are particularly interested in the treatment of this disease. Each speaker will briefly record his "five-year cures of cancer." In this unique symposium clinicians and pathologists will furnish incontrovertible evidence that cancer is curable, and the fact will be emphasized that if all cases of cancer were treated in the incipient stage, the cancer death rate of the United States would be reduced by one-third, or from 150,000 to approximately 100,000.

SYMPOSIUM—TREATMENT OF FRACTURES

The subject of fractures is one of perennial interest to the practicing physician and surgeon, and has an economic importance that is scarcely appreciated. The College has a committee under the chairmanship of Dr. Charles L. Scudder which has been working since 1923 to improve the treatment of fractures on this continent. Correct methods applied early after occurrence of the fracture will secure optimum results. Education of the faculty on the subject of fractures, as well as the education of the medical student and the practitioner in his early years, has formed one of the objectives of this committee. An increase in the number and complexity of fractures is a penalty of mechanical progress and makes im-

cumbent upon the profession adequate preparation to meet this unfortunate situation

The College has taken cognizance of this situation and a symposium on fractures at the Jefferson Hotel at 2 30 Wednesday afternoon has been prepared as an important phase of this Clinical Congress. Fractures of individual bones will be discussed from the standpoints of diagnosis and treatment by members of the Committee on Fractures and other leaders in this field. The educational value of this symposium will be measured by its subsequent effect in the diminution of the period of disability and the increase in the completeness of restoration of function of those who suffer from fractures

SYMPOSIUM TEACHING OF SURGERY AND THE SURGICAL SPECIALTIES

Believing that an excellent opportunity exists to arrive at a plan for the teaching of surgery which will be possible and satisfactory, a committee has been appointed by the American College of Surgeons to study undergraduate, graduate, and postgraduate teaching of surgery and the surgical specialties. The members of the committee are Dr. Fred C. Zapffe, chairman, Dr. Elliott C. Cutler, Dr. Irving S. Cutter, Dr. George J. Heuer, Dr. Alexander R. Munroe, and Dr. Allen O. Whipple.

A number of eminent teachers and clinicians of the United States and Canada have been asked to participate in a symposium on the subject to be presented on Wednesday afternoon at 2 00 at the Jefferson Hotel. Meanwhile, the committee is soliciting the opinions of chiefs or heads of surgical departments in the undergraduate, graduate, and postgraduate medical schools. Based on these opinions, there will be formulated for consideration an outline of approved courses in surgery and the specialties that may be used in building courses in individual schools.

This is not an effort to standardize the teaching of surgery or the specialties. The reports will emphasize what the teachers of these subjects believe to be the best means of imparting fundamental principles, and of laying a sound foundation for future development. It is the underlying desire to arrive at the best and most effective training of the surgeon and the specialist of the future.

SYMPOSIUM INDUSTRIAL MEDICINE AND TRAUMATIC SURGERY

The care of the injured man ranks in importance with the care of those who are disabled through disease. Safety measures for the prevention of in-

jury have been widely adopted by industry, but adequate organization for the care of those who do become ill or injured has not been provided in all industries. The College has conducted investigations and surveys in large areas of the United States to ascertain present medical conditions in industry and to inform employers of adequate methods. Some of the results of these surveys will be presented by the investigators at this symposium at 2 30 Friday afternoon in the ballroom of the Jefferson Hotel, under the auspices of the Board on Industrial Medicine and Traumatic Surgery, of which Dr. Frederic A. Besley is chairman. Other subjects of importance in industrial medicine and traumatic surgery in industry and in the non-industrial world will be included.

ANNUAL MEETING

The annual meeting of the College will convene in the ballroom of the Jefferson Hotel at 1 30 o'clock, Thursday afternoon. The routine reports of the activities will be briefly summarized by the administrative personnel of the College. The Director-General will speak of the progress of new activities, among them (1) The study of facilities for the treatment of cancer, based on information secured through personal surveys. The American College of Surgeons has taken the stand that the best means immediately available to improve the care of cancer cases, and to reduce the excessive cancer mortality, is through the organization of cancer diagnostic clinics in already existing hospitals and other approved institutional clinics where cancer can be specially treated. (2) Industrial medicine and traumatic surgery, results of personal surveys to determine facilities available for the care of the ill and injured in industry, co-operation of the College with industries in formulating plans for the care of employees.

COMMUNITY HEALTH MEETING

For several years the College has presented personal health talks at a large number of community meetings, held principally in cities of from 100,000 to 300,000 inhabitants. These gatherings have been popular with the lay public.

Such a community health meeting is planned for 8 o'clock, Wednesday evening, in the gymnasium of St. Louis University. The program will appeal to the public. It will deal with intimate personal health topics, presented in short, illustrated talks by eight specialists selected from the medical teaching centers of the continent, supplemented by motion pictures. Such programs have been built up by the College during the last twelve years in a manner to interest the public in personal

health problems especially as they pertain to preventable and curable diseases. It is the purpose of the College to interest the public in the fundamental principles of scientific medicine.

EDUCATIONAL AND SCIENTIFIC EXHIBITS

Departmental activities of the College will be demonstrated by means of a series of exhibits placed on the mezzanine floor adjacent to head quarters. These include exhibits by the Committee on Fractures, with Dr. Charles L. Scudder, Boston, chairman in attendance for consultation on the organization of fracture work. Committee on the Treatment of Malignant Diseases, Dr. Robert B. Greenough, Boston, chairman. Registry of Bone Sarcoma, Dr. Dallas B. Pheaster, Chicago, chairman. Board on Medical Motion Picture Films, Dr. J. Bentley Squier, New York, chairman. Industrial Medicine and Traumatic Surgery, Dr. Frederic A. Besley, Waukegan, Illinois, chairman. Cancer Clinic Organization in charge of Dr. Bowman C. Crowell, associate director of the College. Hospital Standardization in charge of Dr. Malcolm T. MacEachern, associate director of the College. Department of Literary Research.

HOSPITAL STANDARDIZATION CONFERENCE

For the fifteenth annual hospital standardization conference of the College, an interesting program of papers, round table conferences and practical demonstrations dealing with many of the problems related to the hospital standardization program of the College has been prepared. The conference opens on Monday morning at 9:30 o'clock in the ballroom of the Jefferson Hotel. On Tuesday morning afternoon and evening sessions will be held in the Tuttle Memorial Auditorium directly across Locust Street from the hotel. The sessions on Wednesday morning and afternoon will be held in the same Auditorium. On Thursday a series of practical demonstrations will be given in certain of the St. Louis hospitals.

The program for this annual conference has been specially planned to interest surgeons, hospital trustees, executives, nurses, etc., and the College extends an invitation to attend this conference to all persons interested in the hospital field.

SURGICAL FILM EXHIBITION

Throughout the week medical motion picture films, both sound and silent, will be exhibited daily at the Statler Hotel. The showing of films demonstrating clinical features of interest, has met with popular acceptance in previous years, and a number of new films will be shown this year.

IMPORTANT DECISIONS

The Board of Regents is considering several fundamental problems of policy with the expectation of arriving at conclusions upon which it can make definite pronouncements. The discussions involve problems to which the College has devoted serious study during the past few years, among them industrial medicine and traumatic surgery and the several bases of compensation. Every credentials committee of the college requires definite information on this subject in passing upon candidates for fellowship.

STATE AND PROVINCIAL EXECUTIVE COMMITTEES

A meeting of the State and Provincial Executive Committees with officials of the College has been called for 11:30 o'clock Wednesday morning at the Jefferson Hotel. These meetings are held annually for the purpose of obtaining information on which may be based the itinerary of the College for its sectional meetings and the desirable grouping of states and provinces.

TECHNICAL EXHIBITION

An extensive technical and educational exhibition, under the direction of Mr. A. D. Ballou, general manager of the Clinical Congress, will occupy the Crystal and Ivory rooms and foyers of the mezzanine floor at the Jefferson Hotel. This exhibition will include surgical instruments and apparatus of all kinds, hospital, laboratory X-ray and other diagnostic and therapeutic equipment, medical books, pharmaceuticals, etc. A visit to the technical exhibition will provide many suggestions for improving the environment of the surgeon, including the newest in physical, therapeutic and mechanical innovations.

HEADQUARTERS

General headquarters for the Clinical Congress will be established at the Jefferson Hotel, 11th and Locust streets, where the ballroom, Crystal and Ivory rooms and foyers adjacent thereto on the mezzanine and second floors have been reserved for the exclusive use of the Congress for scientific meetings, conferences, registration and ticket bureaus, bulletin boards, executive offices, scientific and technical exhibitions, etc. The ballroom of the Statler Hotel at Washington and 9th streets, will be utilized daily for film exhibitions and scientific sessions on Tuesday and Thursday evenings.

ADVANCE REGISTRATION

Attendance at the St. Louis session will be limited to a number that can be comfortably accommodated at the clinics—the limit of attend-

ance being based upon the result of a survey of the amphitheaters, operating rooms and laboratories in the hospitals and medical schools to determine their capacity for accommodating visitors. It will be necessary, therefore, for those who wish to attend the Clinical Congress in St. Louis to register in advance.

Attendance at all clinics and demonstrations will be controlled by means of special clinic tickets, which plan provides an efficient means for the distribution of the visiting surgeons among the several clinics and insures against overcrowding, as the number of tickets issued for any clinic will be limited to the capacity of the room in which that clinic will be given.

A registration fee of \$5.00 is required of each surgeon attending the annual Clinical Congress, such fees providing the funds with which to meet the expenses of the meeting. To each surgeon registering in advance a formal receipt for the registration fee is issued, which receipt is to be exchanged for a general admission card upon his registration at headquarters. This card, which is non-transferable, must be presented in order to secure clinic tickets and admission to the evening meetings.

REDUCED RAILWAY FARES

The railways of the United States and Canada have authorized reduced fares on account of the St. Louis session of the Clinical Congress so that the total fare for the round trip will be one and one-half the ordinary first-class one-way fare. To take advantage of the reduced rates it is necessary to pay the full one-way fare to St. Louis, procuring from the ticket agent when purchasing ticket, a "convention certificate," which certificate is to be presented at headquarters for the signature of the general manager of the Clinical Congress and the visé of a special agent of the railways. Upon presentation of a visé certificate to the ticket agent in St. Louis not later than October 25, a ticket for the return journey by the same route as traveled to St. Louis may be purchased at one-half the one-way fare.

In the eastern, central, and southern states and eastern provinces of Canada tickets may be purchased between October 14 and 20, in other sections of the United States and Canada at earlier dates. The return journey must be completed within thirty days from date of sale of ticket to St. Louis.

The reduction in fares does not apply to Pullman fares nor to extra fares charged for passage on certain trains. Local railroad ticket agents will supply detailed information with regard to dates

ST. LOUIS HOTELS AND THEIR RATES

	Minimum rates with bath	
	Single	Double
American, Market and Seventh Sts	\$1 50	\$2 50
American Annex, Market and Sixth Sts	1 50	2 50
Chase, Lindell Blvd. at Forest Park	3 00	5 00
Clandine, Locust and Eighteenth Sts	2 00	3 00
Congress, Union Blvd. and Pershing Ave	3 00	4 00
Coronado, Lindell Blvd. and Spring Ave	3 00	4 50
Fairmont, Maryland and Euclid Aves	2 50	3 50
Forest Park, W. Pine Blvd. and Euclid	2 50	4 00
Gatesworth, Union and Lindell Blvds	3 00	4 50
Jefferson, Twelfth Blvd. and Locust St	3 00	4 00
Kings-Way, Kingshighway and W. Pine	2 00	3 00
Robert E. Lee, Eighteenth and Pine Sts		3 50
Lennox, Ninth and Washington Ave	3 50	5 00
Majestic, Eleventh and Pine Sts	2 00	3 00
Mark Twain, Eighth and Pine Sts	2 50	4 00
Marquette, Eighteenth and Washington	2 00	3 00
Maryland, Ninth and Pine Sts	2 00	3 00
Mayfair, Eighth and St. Charles Sts	3 50	5 00
Melbourne, Grand Ave. and Lindell	2 50	4 00
Missouri, Locust and Eleventh Sts	2 00	3 00
Park Plaza, Kingshighway at Maryland	4 00	5 00
Roosevelt, Delmar and Euclid Ave	2 50	4 00
Senate, Union Blvd. and Pershing Ave	3 00	4 00
Statler, Ninth and Washington Sts	4 00	6 00
Warwick, Fifteenth and Locust Sts	2 50	4 00

of sale, rates, routes, etc. Stop-overs on both the going and return journeys may be had within certain limits.

Full fare must be paid from starting point to St. Louis, and it is essential that a "convention certificate" be obtained from the agent from whom the ticket is purchased. These certificates are to be signed by the general manager of the Clinical Congress and visé by a special railroad agent at Clinical Congress headquarters on or before October 21. No reduction in railroad fares can be secured except in compliance with the regulations outlined and within the dates specified. It is important to note that the return trip must be made by the same route as used in going to St. Louis, that the certificate must be visé at headquarters during the meeting and return ticket purchased not later than October 25.

An exception to the above arrangement is to be noted in the case of persons traveling from points in certain far western states and British Columbia, who will be able to purchase round trip summer excursion tickets which will be on sale up to and including October 15 with a final return limit of October 31. The summer excursion fare is somewhat lower than the convention fare mentioned above but is available only in certain of the far western states and British Columbia. Tickets sold at summer excursion rates permit traveling to St. Louis by way of a direct route and returning by way of another direct route with liberal stop-over privileges.

PROGRAM FOR EVENING MEETINGS

BALLROOM JEFFERSON HOTEL

Presidential Meeti g—Monday Evening, 8.15

Invocation.

Address of Welcome: EVARIS A. GRAHAM, M.D., St. Louis, Chairman, Committee on Arrangements.

Introduction of Foreign Guests.

Address of Retiring President Intangibles in Surgery ALLEN B. KANAVEL, M.D. Chicago.

Inaugural Address Fundamentals of Specialism. J. BENTLEY SQUER, M.D. New York.

The John B. Murphy Oration in Surgery Pillars of Surgery SIR WILLIAM L. DECOURY WHEELER, M.S. F.R.C.S.I. Dublin, Ireland.

Tuesday Evening, 8.15

Bronchlectasis and Its Treatment by Lobectomy in One Stage. HAROLD BRUNN, M.D. San Francisco.
A Discussion of Some Principles Involved in the Pathology and Treatment of Empyema Thoracis.
JOSEPH A. DAMMA, M.D., New Orleans.

Discussion: EVARIS A. GRAHAM, M.D. and HARRY C. BALLOU, M.D. St. Louis.

An Experimental and Clinical Study of the Use of Radium in the Brain. LOYAL DAVIS, M.D. and MAX CUTLER, M.D. Chicago.

Discussion ERNEST SACKE, M.D. St. Louis.

*Wednesday Evening, 8.15**Gynecological Symposium:*

The Results of Irradiation in the Treatment of Functional Uterine Bleeding. FLOYD E. KERRY, M.D. Philadelphia.

The Detection of Clinically Latent Cancer of the Cervix. WILLIAM P. GRAVES, M.D. Boston.

Discussion: H. S. CROSBY, M.D. and GEORGE GILLHOAM, M.D. St. Louis.

Fracture Oration Fractures about the Elbow. PHILIP D. WILSON, M.D. Boston.

Oration Industrial Medicine and Traumatic Surgery. FREDERICK A. BENTLEY, M.D. Waukegan, Illinois.

*Thursday Evening 8.15**Symposium on Surgery of the Large Bowel*

Diverticulitis of the Large Bowel. VERNON C. DAVID, M.D., Chicago.

The Hopeful Prognosis of Carcinoma of the Colon. FRED W. RANKIN, M.D. Rochester Minnesota.

Discussion WILLARD BARTLETT, M.D. and HARVEY S. MCKAY, M.D. St. Louis.

Some Observations on Appendicitis a Review of Four Thousand Appendectomies. J. M. T. FORDYCE, JR., M.D., Baltimore.

Discussion: JOHN O. BOWER, M.D., Philadelphia, and MALVERN B. CLOXTON, M.D. St. Louis.

Inflammation. SIR GEORGE LINTHALL CHEATLE, K.C.B. C.V.O., F.R.C.S., London, England.

Discussion: MAJOR G. SEELIG, M.D. and ELLIS FISCHER, M.D., St. Louis.

Convocation—Friday Evening, 8.15

Invocation. The RT. REV. WILLIAM SCARLETT, Bishop of the Protestant Episcopal Church for the St. Louis Diocese.

Conferring of Fellowships.

Conferring of Honorary Fellowships.

Presidential Address. The American College of Surgeons Twenty Years of Ambitious Effort. J. BENTLEY SQUER, M.D. New York.

Fellowship Address. Some New Things in Physics. ROBERT ANDREWS MILLIKAN, Ph.D. LL.D. Sc.D. Nobel Laureate Director Norman Bridge Laboratory of Physics, and Chairman of the Executive Council, California Institute of Technology Pasadena.

SYMPOSIUM CANCER IS CURABLE

Thursday, 2 30 P M—Ballroom, Jefferson Hotel

ROBERT B GREENOUGH, M D , Boston, Chairman, Committee on the Treatment of Malignant Diseases

General subject of curability of cancer

WILLIAM J MAYO, M D , Rochester, Minn

General cases of five-year cures

GEORGE W CRILE, M D , Cleveland

JOSEPH C BLOODGOOD, M D , Baltimore

FLOYD E KEENE, M D , Philadelphia

DONALD GUTHRIE, M D , Sayre, Pa

FRANK H LAHEY, M D , Boston

NEIL JOHN MACLEAN, M D , Winnipeg

HOWARD CANNING TAYLOR, M D , New York

Cancer of the Cervix, Uterus and Breast

FRANK W LYNCH, M D , San Francisco

Cancer of the Uterus

CURTIS F BURNAM, M D , Baltimore

LINCOLN DAVIS, M D , Boston

GEORGE GRAY WARD, M D , New York

Cancer of the Pelvic Organs

WILLIAM E CALDWELL, M D , New York

Cancer of the Breast

W WAYNE BABCOCK, M D , Philadelphia

J M T FINNEY, M D , Baltimore

STUART W HARRINGTON, M D , Rochester,
Minn

BURTON J LEE, M D , New York

JONATHAN WAINWRIGHT, M D , Scranton, Pa

Cancer of the Stomach

DR GATEWOOD, Chicago

Cancer of the Kidney, Bladder, Prostate

J BENTLEY SQUIER, M D , New York

HUGH H YOUNG, M D , Baltimore

Cancer of the Kidney and Bladder

WALTMAN WALTERS, M D , Rochester, Minn

Cancer of the Testes

FRANK HINMAN, M D , San Francisco

Cancer of the Bladder, Prostate Testes

EDWARD L KEYES, M D , New York

Malignancy of Cerebral Tumors

WINCHELL MCK. CRAIG, M D , Rochester,
Minn

Tumors of the Central Nervous System

WILLIAM JASON MIXTER, M D , Boston

Cancer of the Larynx

FIELDING O LEWIS, M D , Philadelphia

Cancer of the Mouth, including Lip, Tongue,
Cheek, Tonsils

WILRAY P BLAIR, M D , St Louis

FERRIS SMITH, M D , Grand Rapids

Malignant Tumors of the Eye

JONAS S FRIEDENWALD, M D , Baltimore

Cancer of the Skin

ERWIN P ZEISLER, M D , Chicago

EVENING MEETINGS—SECTION ON OPHTHALMOLOGY AND
OTOLARYNGOLOGY*Tuesday Evening, 8 15—Ballroom, Statler Hotel*

CARL BARCK, M D , St Louis, Presiding

Highways and Byways in Ophthalmology HANS BARKAN, M D , San Francisco

Changes in Ocular Refraction EDWARD JACKSON, M D , Denver, Colo

Thursday Evening, 8 15—Ballroom, Statler Hotel

MAX A. GOLDSTEIN, M D , St Louis, Presiding

History and Development of the Operative Treatment of Facial Palsy ARTHUR B DUEL, M D , New
YorkSuppuration of the Petrous Apex in Relationship to Meningitis WELLS P EAGLETON, M D , Newark,
N J

CONFERENCES—SYMPOSIA—PUBLIC MEETING

THE TREATMENT OF FRACTURES

Wednesday 3 30 P.M.—Ballroom Jefferson Hotel

CHARLES L. SCUDGERS, M.D. Boston, Chairman, Committee on the Treatment of Fractures.

Sterilization in the Treatment of Fractures. PAUL B. MCGOWAN, M.D., Chicago.

Treatment of Fractures of Femur by the Russell Extension Method. W. EMMETT LEE, M.D., Philadelphia.

Fractures of the Pelvis. LLOYD NORMAN, M.D. Birmingham, Ala.

The Exact Role of Physical Therapy in the Treatment of Fractures. CLAY RAY MURRAY, M.D. New York.

Pathological Fractures. ELDONOR L. ELIASON, M.D. Philadelphia.

The Management of Depressed Fractures of the Skull with Brain Injury. HOWARD C. NAFERBERG, M.D. San Francisco.

The Treatment of Posterior Marginal Fracture of the Tibia with Backward Dislocation of the Antalgus. FRANK D. DISNEY, M.D. Kansas City.

Treatment of Compound Fractures. GEORGE V. FORNER, M.D. Pittsburgh.

TEACHING OF SURGERY AND SURGICAL SPECIALTIES

Wednesday 3 00 P.M.—Jefferson Hotel

Interest of the American College of Surgeons in Medical Education. FRANKLIN H. MARTIN, M.D. Director General, Chicago.

Purpose and Work of the Committee on Undergraduate Graduate and Postgraduate Teaching of Surgery and the Surgical Specialties. FREDERICK C. ZAPPE, M.D., Chicago, Chairman.

Undergraduate Teaching of Surgery and the Surgical Specialties. EDWARD C. CURTIS, M.D. Harvard Medical School, Boston.

Graduate Teaching of Surgery and the Surgical Specialties. GEORGE J. HADLEY, M.D. Cornell University Medical College, New York.

Postgraduate Teaching of Surgery and the Surgical Specialties. ALLEN O. WINTER, M.D. Columbia University College of Physicians and Surgeons, New York.

Licensure of the Surgeon and the Specialist. ALEXANDER R. MUNRO, M.D. University of Alberta, Edmonton.

Discussion. Opened by IRVING S. COOPER, M.D. Northwestern University Medical School, Chicago.

HOWARD C. NAFERBERG, M.D. University of California Medical School, San Francisco. SAMUEL C. HANBY, M.D. Yale University School of Medicine, New Haven. OWEN H. WANGENSTEIN, M.D. University of Minnesota Medical School, Minneapolis.

INDUSTRIAL MEDICINE, TRAUMATIC SURGERY

Friday 3 30 P.M.—Ballroom Jefferson Hotel

FREDERICK A. BRIDLEY, M.D. Chairman, Presiding. Industrial Medicine and Traumatic Surgery. FRANKLIN H. MARTIN, M.D., Chicago.

Personal Surveys: a Report of Findings. E. W. WHITMAN, M.D. and M. N. NEWCOMB, M.D. Chicago.

Injuries to the Lung. A. L. LOCKWOOD, M.D., Toronto.

Salivaria and Other Duct Diseases. C. O. SARGENT, M.D. Chicago.

Occupational Diseases. CAREY FRANK MCCOY, M.D. Cincinnati.

Care of Employees in Industry by Physicians and Surgeons in Independent Practice. FREDERICK W. SLOTT, M.D., Chicago.

Method of Evaluating Extent of Injuries. EARL D. McBRIDE, M.D. Oklahoma City.

The Problem of Competition in Industrial Medicine and Traumatic Surgery. H. J. WHITACRE, M.D. Tacoma.

Three Minor but Debilitating Complications of Injuries—Indolent Piloni Injuries, Cattle Hair Infections, and Penetrating Edema. ALLEN B. KARAVEL, M.D. Chicago.

COMMUNITY HEALTH MEETING

Wednesday 7 00 P.M.—St. Louis University Gymnasium

J. BRANTLEY SOUTER, M.D. New York, President, American College of Surgeons, Presiding.

Addresses of Welcome. E. ARTHUR GLEASON, M.D. St. Louis, Chairman, Committee on Arrangements, and REV. A. M. SCHWETZALL, Dean, St. Louis University School of Medicine.

The American College of Surgeons—Its Aims and Objectives. FRANKLIN H. MARTIN, M.D. Director-General, Chicago.

Seven Workers of Medicine. BOWMAN C. CHOWELL, M.D. Chicago.

The Dividend of Medical Science. ALLEN B. KAY, M.D. Chicago.

Choosing Your Hospital. MALCOLM T. MACFARLAND, M.D. Chicago.

Medicine of the Future. G. W. CRILE, M.D. Cleveland.

Cancer—A Curable Disease. RUTHERFORD J. LEE, M.D., New York.

That Ache in Your Back. PHILIP H. KRECHMER, M.D. Chicago.

Why Are You Nervous? ALFRED W. ADAMS, M.D. Rochester, Minn.

Doctors, Hospitals and Patients. ROBERT JOLLY Hamilton, Texas.

Modern Picture. Acute Appendicitis.

ANNUAL HOSPITAL STANDARDIZATION CONFERENCE

Monday 9 30-11 30—Ballroom Jefferson Hotel

ALLEN B. KARAVEL, M.D. Chicago, President, American College of Surgeons, Presiding.

Address of Welcome. CURTIS H. LOAN, M.D. St. Louis.

Greetings from the President Elect. J. BRANTLEY SOUTER, M.D. New York.

Report of the Fifteenth Annual Hospital Standardization Survey and Official Announcement of the 1) List of

Approved Hospitals. FRANKLIN H. MARTIN, M.D. Chicago. Director General, American College of Surgeons.

The Standardized Hospital as a Medical Education Center. ALLEN B. KARAVEL, M.D. Chicago.

Discussion. HORACE J. WHITACRE, M.D. Tacoma, Wash.

The Changing Relationship of the Doctor to his Workshop. G. HARVEY ADAMS, M.D. Toronto.

Discussion. WILLIAM D. CUTLER, M.D. Chicago.

Medical and Hospital Economics. DANIEL CROSBY, M.D., Oakland

Discussion. FREDERIC A. BESLEY, M.D., Waukegan, Ill.
How the Hospital Management and Medical Staff Can Co-operate in Reducing Mortality Rate of Appendicitis. JOHN O. BOWER, M.D., Philadelphia

Discussion. GEORGE DAVID STEWART, M.D., New York
Oxygen Therapy in Hospitals, Equipment and Management. WILLIAM THALHIMER, M.D., Chicago

Discussion. GEORGE W. CRILE, M.D., Cleveland.

Monday, 2 00-5 00—Ballroom, Jefferson Hotel

ALLEN B. KANAWEL, M.D., Chicago, presiding
Pertinent Problems Affecting Hospitals and Their Solution
—From a Nation-Wide Survey. E. MURIEL ANSCOMBE, R.N., St. Louis

Discussion. W. HAMILTON CRAWFORD, Hattiesburg, Miss.
Economic Conditions Affecting Canadian Hospitals, How These Are Being Met. ARTHUR J. SWANSON, Toronto

Discussion. ROSS MILLAR, M.D., Ottawa.
Co-operation of Hospital Boards and Hospital Executives with Medical Staffs in the Diagnosis and Treatment of Cancer. BURTON J. LEE, M.D., New York

Discussion. BOWMAN C. CROWELL, M.D., Chicago
Follow-Up and Study of End Results as Carried on by the Mayo Clinic. ALFRED W. ADSON, M.D., Rochester
Discussion. PHILIP H. KREUSCHER, M.D., Chicago
Fusing the Triple Viewpoints on Nursing—Doctors', Nurses' and Hospital Executives'. MARY M. ROBERTS, R.N., New York

Discussion. DONALD GUTHRIE, M.D., Sayre, Pa.
Basic Standards for Schools of Nursing. REV. ALPHONSE M. SCHWITALLA, S.J., Ph.D., St. Louis.
Discussion. J. DEWEY LUTES, Chicago

Tuesday, 10 00-12 30—Tuttle Memorial Auditorium

L. H. BURLINGHAM, M.D., St. Louis, presiding
Depression Developments in Relation to Hospital Economics. B. C. MACLEAN, M.D., New Orleans

Symposium—Efficiency and Economics as Applied to The Clinical Laboratory. J. J. MOORE, M.D., Chicago

The X-Ray Department. EDWARD H. SKINNER, M.D., Kansas City, Mo.

The Physical Therapy Department. JOHN S. COULTER, M.D., Chicago

The Administration of Anesthesia. JOSEPH MCNEARNEY, M.D., St. Louis

The Administration of the Food Service. EUGENIA SHRADER, St. Louis

The Handling of Surgical Dressings and Supplies. SISTER PHILOMENA, St. Louis

General Discussion. Opened by E. E. KING, St. Louis

Tuesday, 2 00-5 00—Tuttle Memorial Auditorium

Round Table Conference. Administrative, Professional, Economic, and Social Problems Affecting Hospitals. Conducted by R. C. BUEKER, M.D., Madison, Wis.

Tuesday, 8 00-10 00—Tuttle Memorial Auditorium

Joint Meeting for Hospital Trustees, Hospital Executives, and Members of Medical Staffs. PAUL H. FESLER, Chicago, presiding

Greetings from Trustees of the Hospitals of St. Louis. AARON WALDBERG, St. Louis

Criteria to be Observed in Selecting the Governing Body of a Hospital. C. W. MÜNGER, M.D., Valhalla, N. Y.

Discussion. FRANK RAND, St. Louis.
Responsibility of Governing Body in Selecting Superintendent. C. G. PARKALL, M.D., Rochester, N. Y.

Discussion. FRANK V. HAMMAR, St. Louis

How Hospital Trustees Can Keep Abreast with the Advances in Hospital Administration. MATTHEW O. FOLEY, Chicago

Discussion. W. W. MARTIN, St. Louis

Removing Hospitals from the Influence of Politics. JOHN A. McNAMARA, Chicago

Discussion. E. P. HOGAN, M.D., Birmingham, Ala.

General Discussion. Opened by REV. R. D. S. PUTNEY, St. Louis

Wednesday 10 00-12 30—Tuttle Memorial Auditorium

BERT W. CALDWELL, M.D., Chicago, presiding
Handling of Communicable Diseases in Connection with a General Hospital. HENRY ROWLAND, Toronto

Discussion. WALTER C. G. KIRCHNER, M.D., St. Louis
The Individual Doctor's Responsibility for Clinical Records. WALTER F. COLE, M.D., Greensboro, N.C.

Discussion. DEWELL GANN, JR., M.D., Little Rock, Ark.
The Value and Scope of Medical Social Service Work in the Hospital. GRACE BEALS FERGUSON, St. Louis

Discussion. ROBERT E. NEFF, Iowa City, Iowa
How the Medical Social Worker Can Assist in the Present Economic Situation. RUTH LEWIS, St. Louis

Discussion. BERYL B. ANSCOMBE, R.N., Kansas City
The Role of the Social Worker in the Diagnosis and Treatment of Cancer. ELEANOR COCKERILL, St. Louis

Discussion. FRANK L. RECTOR, M.D., Evanston, Ill.
General Discussion. Opened by B. A. WILKES, M.D., Cape Girardeau, Mo.

Wednesday 2 00-5 00—Tuttle Memorial Auditorium

Round Table Conference. Administrative, Professional, Economic, and Social Problems as Affecting Hospitals. Conducted by ROBERT JOLLY, Houston, Texas

Thursday 9 00-12 00—Jewish Hospital

Round Table Conferences and Demonstrations. Conducted by ROBERT JOLLY, Houston, Texas, MALCOLM T. MACEachern, M.D., Chicago, assisted by E. MURIEL ANSCOMBE, R.N., St. Louis.

Preparedness for Emergencies in Hospitals. JEROME SIMON, M.D., and CLARA COLEMAN, R.N., St. Louis

Operating Room Management with Demonstration of Detailed Procedure in Handling Major Operations. MAX MYER, M.D., and MARIE DOWLER, R.N., St. Louis

Food Service with Demonstration of Various Types of Tray Set ups, General and Special or Therapeutic Diets. LLEWELLYN SALE, M.D., St. Louis, and BETHEL CURRY, B.S., St. Louis

Handling Supplies. FLORENCE KING, St. Louis
Staff Education with Demonstration of Nurses Conferences. EDNA E. PETERSON, R.N., St. Louis

Thursday 2 00-5 00—St. Mary's Hospital

Round Table Conference and Demonstrations. Conducted by MALCOLM T. MACEachern, M.D., Chicago, ROBERT JOLLY, Houston, Texas, assisted by MOTHER M. CONCORDIA, St. Louis

Organization of the Hospital with Exhibition of Organization Charts. REV. ALPHONSE M. SCHWITALLA, S.J., Ph.D., St. Louis

Admission of Patients with Demonstration of Complete Procedure. (a) The medical aspects. GORDON O. BROWN, M.D., St. Louis. (b) The social service aspects. IRENE MORRIS, St. Louis.

Nursing Administration and Nursing Service. SISTER M. HENRIETTA, R.N., A.M., St. Louis

Problems Associated with Clinical Records. E. LEE SHRADER, M.D., St. Louis

Organization and Management of the Pediatric Division. JULIUS A. ROSSEN, M.D., St. Louis

PRELIMINARY CLINICAL PROGRAM

GENERAL SURGERY GYNECOLOGY OBSTETRICS ORTHOPEDICS UROLOGY
PROCTOLOGY SURGICAL PATHOLOGY ETC.

ST LOUIS UNIVERSITY MEDICAL SCHOOL

ST MARY'S HOSPITAL

Tuesday

WILLIAM T. COUGHLIN—9. Breast tumor carcinoma of the breast.

JOHN STEWART—9. Stomach and duodenal ulcer

W. W. GRAVES and LEROY SANTI—9. Breast tumor and duodenal ulcer

PHILIP HOFFMAN, FRANKLIN ALFREY and CARL VOEG—8. Orthopedic clinic.

Wednesday

WILLIAM KIRWIN—9. Gynecological operations, prolapse of uterus, carcinoma of uterus, Cesarean section

LEROY SANTI—9. The X-ray in gynecology

WILLIAM D. COLLIER—9. Demonstration of gynecological specimens

Thursday

WILLIAM D. LUDGISTON—9. Cancer of the neck

LOUIS KAMETZ—9. Gall-bladder operations

RALPH KIMMELA and WILLIAM D. COLLIER—9. Demonstration of gall-bladder cases

C. E. RUTENFRANZ and JOSEPH GLENN—9. Nephroscopy

Friday

CARROLL SMITH—9. Götter operation

CHARLES SKEWER—9. Carcinoma of the breast

RALPH A. KIMMELA and WILLIAM D. COLLIER—9. Götter cases

H. H. KRANZLOWITZ and GEORGE H. KOCHER—9. General surgical operations and demonstration of cases

FIRMEN DESLOGE HOSPITAL

Tuesday

E. A. DORR—9. Ovarian extracts

E. L. SWANDELL—9:15. Theoria and ovarian extracts in castration

A. A. WICKER—9:30. The effect of theoria on castration

J. B. MITCHELL—9:30. The action of theoria and theoria on ovaries

G. Q. BRONN and H. L. LAMER—10:15. Theoria and ovarian extracts in epilepsy

W. D. COLLIER—10:30. The effect of theoria on the genital tract of the female white rat

Wednesday

ALBERT KUNITZ—9. Autonomic nervous system in relation to surgery

K. CHRISTIANSEN—9:30. The autonomic nervous system and special senses

G. Q. BRONN and A. P. BRONN—9:45. Studies in bile peritonitis

R. A. KIMMELA—10:30. Bacterial endocarditis

Thursday

A. B. HERTZMAN and F. E. FRANK—9. Demonstration and discussion of cerebral circulation

JOHN AUST—9:45. Studies on the contraction of glands and Reichert substances

A. P. BRONN—10:04. Newer aspects of asplenia

W. H. GRITTE—10:35. Food constitution in relation to food consumption (appetite)

Friday

ALBERT KUNITZ—9. Structural changes in the autonomic ganglia and ganglion cells associated with certain diseases

FRED KATZMAN—9:30. Anterior pituitary hormone

M. B. FLETCHER and L. R. JONES—9:30. Serum vitamin in rabbits

G. Q. BRONN and W. F. HOLLER—9:30. Studies on peritoneal anatomy

ST JOHN'S HOSPITAL

Monday

Staff—9. Dry clinic, bone cases, A. P. BRONN. Bone development, A. E. HOWE and C. LUDGISTON

Parks disease, LEO WILLI. Fracture, JOSEPH PIERCE. X-ray demonstration of bone cases

W. H. VOOT and associates—9. Obstetrical clinic

Tuesday

BRAMFORD LEWIS, G. LAMBELL, LEO BARTHA, C. D. FICKELL, O. H. KIMMEL, J. M. SCHATTY and ROBERT F. HACKETT—9. Urological operations

G. P. J. FALK and ARTHUR BRUNN—9. Discussion of diagnostic and medical aspects of urological cases

Staff—9. Dry clinic, diseases of the lungs, J. L. MARSH. Carcinoma of lungs, R. McCLANON. Abscess of lungs, A. McCLANON. Heart and lungs in surgical cases, GEORGE CAPNEY. Empyema

Wednesday

L. M. RICHMAN, PERCY H. SWANLICK, WILLIAM VOOT and M. WELSH—9. Gynecological operations

Staff—9. General surgical operations, WILLIAM F. OLSON. Gall-bladder surgery, J. McHALE. Deaf, Stomach and intestinal operations, L. H. BOKER. Abdominal surgery, G. T. GAINY. Carcinoma of the breast, A. McCLANON and J. J. HANCOCK. Discussion of diagnostic and medical aspects of these cases

A. P. MURPHY, J. McHALE, A. McCLANON, G. P. J. FALK and L. H. BOKER—9. Borderline medical and surgical cases

C. H. NEILSON, F. KRAMER, J. McFADDEN, W. P. OLSON and H. N. ALLER—9. Sympathectomy on goats

Thursday

Staff—9. General surgical operations, BRAMFORD LEWIS. Urological operations, WILLIAM VOOT. Gynecological operations, J. McHALE. Deaf, Stomach and intestinal operations, W. P. OLSON. Götter operation, W. K. McINTYRE. Radical operation, E. H. BOWEN. Demonstration of anesthetic methods and apparatus, A. P. MURPHY and H. G. BRUNN. Discussion of diagnostic and medical aspects of these cases

Staff—2 Dry clinic J P COSTELLO Diagnosis of acute abdominal conditions in children. R HYLAND Traumatic surgery J MCFADDEN Neurological aspects of traumatic surgery W GALLAGHER Treatment of varicose ulcers O P J FALK and J J HAMMOND Symposium on gall-bladder diseases R HYLAND The acute surgical abdomen

Friday

Staff—9 General surgical operations P H SWAHLEN and H J RINGO Gynecological operations WILLIAM GALLAGHER Abdominal operations T R KENNEDY General surgery FRED BAILEY Abdominal surgery A J RAEMDONCK and R F BARNES Discussion of diagnostic and medical aspects of these cases
A A WERNER—2 Endocrine disturbance
WILLIAM VOGT and J A HARDY—2 Ectopic gestation
A E HORWITZ—2 Orthopedic surgery

MOUNT ST ROSE SANITARIUM

Tuesday

Symposium on Medical and Surgical Aspects of Pulmonary Tuberculosis

C L BOISLINIERE—9 Diagnosis of pulmonary tuberculosis
E H KESSLER—9 20 Roentgen findings in pulmonary tuberculosis
ALPHONSE MCMAHON—9 40 Differential diagnosis of toxic thyroid and pulmonary tuberculosis
A C HENSKE—10 30 Pneumothorax in pulmonary tuberculosis
C W EHLERS—10 50 Oleothorax in pulmonary tuberculosis
J L MUDD—11 10 Surgical treatment of pulmonary tuberculosis

Wednesday

J L MUDD—9 Thoracoplasty and phrenicectomy

Thursday

J L MUDD—9 Thoracoplasty and phrenicectomy
J L MUDD—2 30 Exhibition of postoperative patients

Friday

J L MUDD and C W EHLERS—9 Demonstration of pneumothorax, oleothorax and phrenicectomy cases.

ST MARY'S INFIRMARY

Tuesday

LOUIS RASSIEUR—9 Abdominal surgery
HARVEY S MCKAY—10 30 Goiter clinic.

Wednesday

WILLIAM T COUGHLIN—9 Surgery of the head and neck
CARROLL SMITH—9 Surgery of the colon and rectum
HYMAN I SPECTOR—2 Chest surgery

Thursday

ROBERT D ALEXANDER—9 Rectal surgery
CHARLES F SHERWIN—9 Breast surgery
PHILIP HOFFMAN—2 Orthopedic surgery

Friday

WILLIAM KERWIN—9 Gynecology
WALTER E HENNERICH—9 General surgery

ST ANTHONY'S HOSPITAL

Tuesday

W GAYLER—9 Gynecological clinic.
E H RUND—9 Hysterectomy
J E FERRIS—10 30 Gall-bladder surgery
REUBEN SMITH—10 30 Hernia operations

Wednesday

NEIL MOORE and E E SEXTON—9 Diseases of the kidneys
WILLIS YOUNG—10 30 Plastic surgery
M J PULLIAM—10 30 Appendectomy

Thursday

H S MCKAY, J C LYTER, M J PULLIAM, R M S BARRETT and P NEU—9 Stomach and gall-bladder operations, consideration of medical and pathological aspects, choice of anesthetics

Friday

H S MCKAY, M J PULLIAM, R M S BARRETT and P NEU—9 General surgical clinic, demonstration of pathological specimens, lantern slides.

WASHINGTON UNIVERSITY MEDICAL SCHOOL

BARNES HOSPITAL

EVARTS A GRAHAM, M B CLOPTON, A O FISHER, G H COPER, W H COLE, DR ALLEN, W R RAINEY, I Y OLCH, R ELMAN and P HEINBECKER—9, daily General surgical operations
ERNEST SACHS and ROLAND M KLEMM—9, daily Neurological surgery
JOHN R CAULK, D K ROSE, J H SANFORD, OTTO J WILHELM and V R DEAKIN—9, daily Genito-urinary surgery
VILRAY P BLAIR, J B BROWN and W G HAIN—9, daily Oral and plastic surgery
J A KEY, ARCHER O'REILLY, C A STONE, J W STEWART, T P BROOKES and F A JOSTES—9, daily Orthopedic operations
H S CROSSEN, OTTO H SCHWARZ, F J TAUSSIG, Q U NEWELL, C D O'KEEFE and R J CROSSEN—9, daily Gynecological operations

ST LOUIS MATERNITY HOSPITAL

OTTO H SCHWARZ, G D ROYSTON, F P MCNALLY, T K BROWN and R PADDOCK—9, daily Obstetrical operations
H S CROSSEN, OTTO H SCHWARZ, G D ROYSTON, Q U NEWELL, F P MCNALLY, O S KREBS, C D O'KEEFE, T K BROWN, C R WEGNER, R PADDOCK, R J CROSSEN, M A ROBLEE and J E HOBBS—2, daily Demonstration of obstetrical and gynecological cases and specimens, clinics on cancer of the uterus, sterility and electrocoagulation

BARNES HOSPITAL, CHILDREN'S HOSPITAL, MALLINCKRODT RADIOLOGICAL INSTITUTE

Clinical Demonstrations Daily 9 and 2
ERNEST SACHS. Cases of brain tumors
ROLAND KLEMM. Sympathectomy
ERNEST SACHS and ROLAND KLEMM. Trigeminal neuralgia

- ERBERT SAGES and COEN PILCHER. Pathology of brain tumors.
- VILRAY P. BLAIR and J. B. BROWN. Carcinoma about the mouth.
- J. B. BROWN. Carcinoma of the larynx.
- VILRAY P. BLAIR and I. Y. OUCH. Pathology of parotid tumors.
- J. R. CAULE. () Transurethral prostatectomy; (s) use of the cauter punch with pathological studies of the removed tissue.
- D. K. ROSE. (1) The relationship of intracystic pressure to the formation of diverticula of the bladder; (s) the application of the cystometer for measuring bladder pressure. (3) carcinoma of the kidney and hypernephroma.
- H. L. WHITE. Mechanism of carcinoma of the breast in re.
- L. Y. OUCH. Pathology of carcinoma and mortalities.
- J. ALBERT KEY. (1) Clinical and experimental observations on chronic arthritis; (s) internal derangements of the knee joint; (3) treatment of osteomyelitis with bacterioid ointment.
- J. ALBERT KEY and FRANKLIN WALTER. The effect of venous stasis on the healing of experimental fractures.
- J. ALBERT KEY and ROBERT MOORE. The effect of syn- pathectomy on the healing of bone and cartilage.
- GLOVER H. COOPER. () The treatment of fractures of the forearm. () reduction of dislocation of the sem- tumer bone.
- ALBERT HARTMAN. The use of combined solution in surgery.
- R. C. MCCARTER. A study of the cases of pyloric stenosis in the St. Louis Children's Hospital.
- J. BROTHMAN. () Discussion on the use of tetanus antitoxin. () clinical applications of bacteriophage.
- ROBERT ELKAN. The treatment of surgical shock with particular reference to the use of ascia solutions.
- WARREN R. RAINIER. Minor surgical procedures about the anus and rectum.
- GLOVER H. COOPER. Surgical treatment of carcinoma of the colon and rectum.
- H. A. BULLOCK and I. Y. OUCH. Clinical and pathological manifestations of diseases of parathyroid glands.
- A. D. CAIR, ROBERT F. PARKER and MARGARET SMITH. The clinical and pathological manifestations of tumors of the islands of Langerhans.
- N. A. WORMACK and E. A. GRAHAM. The surgery of hypothyroidism.
- E. A. GRAHAM. Estimating the risk in operations on the biliary tract.
- SHERWOOD MOORE and LOUIS ARTER. Techniques of cholecystography.
- SHERWOOD MOORE. Interpretation of cholecystograms.
- DAVID LUTEN. The clinical syndromes of coronary thrombosis in relation to upper abdominal pain.
- JULIUS JENSEN. The evaluation of operative risk through a clinical study of the circulation.
- H. L. ALLEGRA. Purpura in relation to abdominal pain.
- D. P. BARR. Significance of pathological calcification.
- D. P. BARR and LOUIS B. BARR. Pituitary gigantism and dwarfism.
- D. P. BARR and GLOVER H. COOPER. Mifflin's disease elephantiasis and the Kaposi's operation of apoplexy, especially in relation to surgical problems.
- ROBERT EYAN. Modern treatment of diabetic arteriosclerosis and gangrene.
- WILLIAM H. OUNTER. Chemical management of the extremities in gangrene.
- L. Y. OUCH. Pathology of the blood vessels of the extremities in gangrene.
- RALPH MCCORMICK. Diagnosis of fungus infections.
- MCKIN MARRIOTT. Vitamins in clinical medicine.
- L. WILSON THOMPSON. Value of the Schilling test in the study of severe surgical conditions.
- J. F. BURROCK. The tuberculin test in the diagnosis of active tuberculous infection.
- DR. LLOYD. Anomalies of renal veins and arteries.
- GEOFFREY D. WILLIAMS. Anomalies of the recurrent laryngeal nerve with relation to the thyroid gland.
- E. L. KEYS, JR. () Anomalies of the superior laryngeal nerve; () anomalies of the mesenteric attachment with relation to volvulus.
- SHERWOOD MOORE and OSCAR ZINK. The veins and fistulae of the thorax.
- J. HOY SAMPSON. Intravenous pyelography.
- SHERWOOD MOORE and D. K. ROSE. Interpretations of pyelograms.
- HENRY WILSON and WALTER SEIBEL. Reduction of hernia under fluoroscopic control.
- SHERWOOD MOORE, OSCAR ZINK and HENRY WILSON. X-ray interpretation of chronic arthritis.
- CHARLES O'KEEFE. Hysteroscopy.
- J. W. LARMORE. () Gastric and duodenal ulcer etiology and treatment. (s) chronic duodenal ulcers.
- H. W. WILSON. Roentgenology of extra-alimentary tumors.
- J. W. LARMORE. Diagnosis of chronic appendicitis.
- J. W. LARMORE, ROBERT EYAN and CHARLES DEERY. Diagnosis of diseases of the caecum.
- JOHN CAULE. Diagnosis and treatment of renal tumor.
- J. W. LARMORE. Diagnosis and treatment of lesions of the esophagus.
- SHERWOOD MOORE and M. F. ARNOLD. Diagnosis and treatment of foreign bodies in the respiratory tract.
- E. A. GRAHAM. Significance of intrathoracic septic pneumonia.
- J. J. SINGER, ALFRED GOLDMAN, HARRY BULLOCK and MILTON SMITH. Diagnostic and therapeutic procedures of value in diseases of the lungs (pneumonia, abscess, etc., use of lipiodol, postural drainage).
- DR. SCHWENK. Anomalies of origin and position of the phrenic nerve.
- E. A. GRAHAM, DUFF S. ALLEN and J. J. SINGER. Surgery in the treatment of pulmonary tuberculosis.
- PAUL D. CANNON (Boston Hospital, Evansville, Ind.) After-cure of the Clara Miller (Quincy II) After-cure of the tuberculosis patient.
- HARRY BULLOCK and H. A. MCCORMICK. The mechanism of the development of tuberculous pneumonia following thoracoplasty.
- E. E. GLENN. Atelectasis in pulmonary tuberculosis.
- KENNETH BURDICK, PHILIP VARNER and DUFF ALLEN. Etiology of lung abscess.
- J. J. SINGER, DUFF ALLEN and E. A. GRAHAM. Diagnosis and treatment of lung abscess.
- J. J. SINGER, H. W. BULLOCK and E. A. GRAHAM. Diagnosis and treatment of bronchiectasis.
- E. A. GRAHAM. Caustic pneumostomy for chronic pulmonary suppuration.
- H. A. MCCORMICK. Pathogenesis of brain abscess associated with pulmonary suppuration.
- DUFF ALLEN. Hemorrhage, its treatment and relation to the production of empyema.
- E. A. GRAHAM. () Treatment of acute empyema, () treatment of chronic empyema.
- ELMER SMITH, DUFF ALLEN and E. A. GRAHAM. Surgical treatment of heart disease.
- ALFRED GOLDMAN. Sedimentation studies on pleural fluids.
- J. V. COOKE. Mediastinal involvements of leukemia.
- J. J. SINGER, HARRY BULLOCK and HENRY CARROLL. Diagnosis and treatment of carcinoma of the lung.

- J J SINGER and HARRY BALLON Diagnosis and treatment of mediastinal tumors
 HERBERT CARLSON Superior vena caval obstruction
 HARRY BALLON and HUGH WILSON The esophagus stomach and heart following unilateral phrenicectomy
 HARRY BALLON, HERBERT CARLSON and F A GRAHAM The effect of phrenicectomy upon cough
 HERBERT CARLSON Postoperative pulmonary complications
 PETER HFINBUCKER The nervous regulation of respiration
 WARREN H COLF and NATHAN WOMACK (1) Experimental production of pathological changes in the thyroid gland typical of exophthalmic goiter, (2) repair in the thyroid gland, (3) effects of certain extracts on basal metabolism
 WARREN H COLF Studies on liver function
 ROBERT ELMAN (1) Value of gradual decompression of

- the obstructed intestine, (2) the rôle of the pylorus in the regulation of gastric acidity
 ROBERT ELMAN and I A GRAHAM Pathogenesis of the 'strawberry' gall bladder
 ROBERT ELMAN and J B TAUSIG Cholesterol function of the gall bladder and the formation of cholesterol gallstones
 ROBERT ELMAN and WARREN H COLF Cause of death in acute portal obstruction
 I Y OLCH (1) The use of micro incineration in the study of surgical pathological tissues, (2) studies of the liver glycogen in certain surgical diseases
 PETER HFINBUCKER The sensory and motor nerve changes during spinal anesthesia
 GLOVER H COHRER (1) Selective distribution of portal blood in the liver, (2) effect of urinary bladder mucosa on osteogenesis in the dog
 J ALBERT KFY Intra-articular anaphylaxis
 M B CLOPTON Indications for and results in splenectomy

JEWISH HOSPITAL

Tuesday

- ELLIS FISCHEL, FRANK JONAS and J PROBSTIN—9 General surgery
 SAMUEL NEWMAN—9 Rectal surgery
 H FRIEDLST, I J TAUSIG, S A WEINTRAUB, GROVER HIES, S F ABRAMS and DR PATTON—2 Obstetrical clinic
 DRS GREY and SOMOCAY—2 Demonstration and discussion of experimental work of surgical significance

Wednesday

- R M KLEMM—9 Neurosurgical clinic
 H FRIEDLST, I J TAUSIG, S A WEINTRAUB, GROVER HIES, S F ABRAMS and DR PATTON—9 Gynecological operations
 DRS SINGER, SIMON and FRANK—2 Medical and surgical thoracic clinic with demonstration of unusual X ray films

Thursday

- MAX W. MYER, HARRY SANDPFLER, F V M. MARTIN and E. K. DIXON—9 General surgery
 B. MAY, D. K. ROSE and McCLELLY YOUNG—9 Genito-urinary surgery
 Medical Staff—2 Pre-operative medical care of patients
 PAUL LOWENSTEIN and J PROBSTIN—3 Technique of injection of varicose veins

Friday

- ELLIS FISCHEL, WILLARD BARTLETT and PAUL LOWENSTEIN—9 General surgery
 F H ALBRECHT, IRVING JOSTIS and J A KFY—9 Orthopedic surgery
 S GREY—2 Pathological demonstration
 B MAY, D K ROSE and McCLELLY YOUNG—2 Urological dry clinic
 P C SCHNOEBELE—3 X ray demonstration of gastrointestinal lesions

BETHESDA HOSPITAL

Tuesday

- ROLAND HILL and B W KLIPPEL—9 General surgical operations

Thursday

- ROLAND HILL and B W KLIPPEL—9 General surgical operations

BARNARD IRISH SKIN AND CANCER HOSPITAL

Tuesday

- IRVING J. TAUSIG, S S LEVIN, F S AUER and FRED LAMBERT—9 Surgery and radium therapy in cancer of the uterus and vulva
 IRVING J. TAUSIG, GEORGE GILLIORN, S S LEVIN, F S AUER, IRVING LAMBERT, KATI SPAIN and MARION WACHOWIAK—2 Malignancy index in gynecological cancer, technique of vulvar operations, specimens

Wednesday

- ELLIS FISCHEL, C I SHERWIN and GEORGE GAFNEY—9 Radical surgery and interstitial radium therapy
 D P BARR, C M STROUD and I C ERNST—2 Internal medicine and radiography in relation to cancer

Thursday

- GEORGE GILLIORN, S S LEVIN, I S AUER, IRVING LAMBERT, KATI SPAIN and MARION WACHOWIAK—9 Surgery and radium therapy in cancer of the uterus
 M G SLELIC, L H JORSTAD and I C ERNST—2 Demonstration of the production of tar cancer, pathological specimens X rays and photomicrographs of unusual problems in malignancy, specimens of crown gall in plants produced by bacillus tumefaciens, studies of mitochondria in cancer, reticulum in cancer growth

Friday

- W I LEIGHTON, GRAYSON CARROLL, THOMAS M MARTIN and J C LANDRIU—9 Surgical cancer therapy
 M I INCMAN, RICHARD WEISS, A H CONRAD, C V LANE and M F ENCMAN, JR—2 Amoebic and phagedenic ulcers and ulcers of unknown cause, presentation of cases, lantern slides

ST LOUIS COUNTY HOSPITAL

Tuesday

- I A JOSTES—9 Orthopedic clinic

Wednesday

- F I DORSETT—9 Gynecology

Thursday

- W I LEIGHTON—9 General surgery

Friday

- F L DAVIS—9 Genito urinary surgery

- EDMUND SACINT and COE PILCHER. Pathology of brain tumors.
- VILRAY P. BLAIR and J. B. BROWN. Carcinoma about the mouth.
- J. B. BROWN. Carcinoma of the larynx.
- VILRAY P. BLAIR and I. V. OLCH. Pathology of parotid tumors.
- J. R. CAULK. (1) Transurethral prostatectomy, (2) use of the cautery punch with pathological studies of the removed tissue.
- D. E. ROSE. (1) The relationship of intracystic pressure to the formation of diverticula of the bladder; (2) clinical application of the cystometer for measuring bladder pressures; (3) carcinoma of the kidney and hypernephroma.
- H. L. WHITE. Mechanism of urinary excision.
- I. V. OLCH. Pathology of carcinoma of the breast in relation to clinical features and mortality.
- J. ALBERT KEY. (1) Clinical and experimental observations on chronic arthritis; (2) internal derangements of the knee joint; (3) treatment of osteomyelitis with bacterioidal ointment gauze.
- J. ALBERT KEY and FRANKLIN WALTON. The effect of venous stasis on the healing of experimental fractures.
- J. ALBERT KEY and ROBERT MOORE. The effect of sympathectomy on the healing of bone and cartilage.
- GLOVER H. CORNICK. (1) The treatment of fractures of the forearm; (2) reduction of dislocation of the semilunar bone.
- ALBERT HARTMANN. The use of "combined solution" in surgery.
- R. C. MCCABEE. A study of the causes of pyloric stenosis in the St. Louis Children's Hospital.
- J. BROMBERGER. (1) Discussion on the use of tetanus antitoxin; (2) clinical applications of bacteriology.
- ROBERT ELIAS. The treatment of surgical shock with particular reference to the use of ascitic solutions.
- WALTER R. RADLEY. Minor surgical procedures about the anus and rectum.
- GLOVER H. CORNICK. Surgical treatment of carcinoma of the colon and rectum.
- H. A. BECKER and I. V. OLCH. Clinical and pathological manifestations of diseases of parathyroid glands.
- A. D. CARR, ROBERT F. PARKER and MARGARET SMITH. The clinical and pathological manifestations of tumors of the islands of Langerhans.
- N. A. WOMACK and E. A. GRAHAM. The surgery of hypoparathyroidism.
- E. A. GRAHAM. Estimating the risk in operations on the biliary tract.
- SHERWOOD MOORE and LOUIS ARTHUR. Techniques of cholecystography.
- SHERWOOD MOORE. Interpretation of cholecystograms.
- DAVEY LUTER. The clinical syndrome of coronary thrombosis in relation to upper abdominal pain.
- JULIUS JENSEN. The evaluation of operative risk through a clinical study of the circulation.
- H. L. ALLEN. Peritonitis in relation to abdominal pain.
- D. P. BARR. Significance of pathological calcification.
- D. P. BARR and LOUIS H. BERNARD. Pituitary gigantism and dwarfism.
- D. P. BARR and GLOVER H. CORNICK. Mayo's disease: hyperparathyroidism and the Kandeloo operation.
- ROBERT EVANS. Modern treatment of syphilis, especially in relation to surgical problems.
- WILLIAM H. OGDEN. Clinical management of diabetic arteriosclerosis and gangrene.
- L. J. OLCH. Pathology of the blood: cause of the extremities in gangrene.
- RAINE MCKENZIE. Diagnosis of fungus infections.
- MCKIN MARRIOTT. Vitamins in clinical medicine.
- LAWRENCE THOMPSON. Value of the Schilling hemogram in the study of acute surgical conditions.
- J. F. BRIDGEC. The tuberculin test in the diagnosis of active tuberculous infection.
- DR. LEVY. Anomalies of renal veins and arteries.
- GEORGE D. WILLIAMS. Anomalies of the recurrent laryngeal nerve with relation to the thyroid gland.
- E. L. KRYER, JR. (1) Anomalies of the superior laryngeal nerve; (2) anomalies of the axillary attachment with relation to volvulus.
- SHERWOOD MOORE and OSCAR ZUCK. The value and limitations of X-ray therapy.
- J. HAY SUMNER. Intravenous pyelography.
- SHERWOOD MOORE and D. E. ROSE. Interpretations of pyelograms.
- HUGH WILSON and WALTER SIEGEL. Reduction of fractures under fluoroscopic control.
- SHERWOOD MOORE, OSCAR ZUCK and HUGH WILSON. X-ray interpretation of chronic arthritis.
- CHARLES O'KEEFE. Hysterosalpingography.
- J. W. LARMORE. (1) Oestric and chondral stercer etiology and treatment; (2) chronic chondral diseases.
- H. W. WYER. Roentgenology of extra-alimentary trusses.
- J. W. LARMORE. Diagnosis of chronic appendicitis.
- J. W. LARMORE, ROBERT E. GOS and CHARLES DOVER. Diagnosis of diseases of the cecum.
- JOHN CAULK. Diagnosis and treatment of renal phlebocysts.
- J. W. LARMORE. Diagnosis and treatment of lesions of the esophagus.
- SHERWOOD MOORE and M. F. ARBUCKLE. Diagnosis and treatment of foreign bodies in the respiratory tract.
- E. A. GRAHAM. Significance of intrathoracic septic processes.
- J. J. SINGER, ALFRED GOLDMAN, HARRY BALLOU and MILTON SMITH. Diagnostic and therapeutic procedures of value in diseases of the lungs (pneumothorax, emphysema, use of lipiodol, postural drainage).
- DR. SCHURMANN. Anomalies of origin and position of the phrenic nerve.
- E. A. GRAHAM, DUFF S. ALLEN and J. J. SINGER. Surgery in the treatment of pulmonary tuberculosis.
- PAUL D. CHENEY (Bochum Hospital, Evansville, Ind.) and CLARA MILLER (Quincy, Ill.) After-care of the thoracoplasty patient.
- HARRY BALLOU and H. A. MCCORDOCK. The mechanism of the development of tuberculous processes following thoracoplasty.
- E. E. GORDON. Atelectasis in pulmonary tuberculosis.
- KENNETH BURTON, PHILIP VAREY and DUFF ALLEN. Etiology of lung abscess.
- J. J. SINGER, DUFF ALLEN and E. A. GRAHAM. Diagnosis and treatment of lung abscess.
- J. J. SINGER, HARRY BALLOU and E. A. GRAHAM. Diagnosis and treatment of bronchiectasis.
- E. A. GRAHAM. Cautery pneumostomy for chronic pulmonary suppuration.
- H. A. MCCORDOCK. Pathogenesis of brain abscess associated with pulmonary suppuration.
- DUFF ALLEN. Hemithorax, its treatment and relation to the production of emphysema.
- E. A. GRAHAM. (1) Treatment of acute emphysema; (2) treatment of chronic emphysema.
- ELSWORTH SMITH, DUFF ALLEN and E. A. GRAHAM. Surgical treatment of heart disease.
- ALFRED GOLDMAN. Sedimentation studies on pleural fluids.
- J. V. CONLEY. Mediastinal involvements of leukemia.
- J. J. SINGER, HARRY BALLOU and HERBERT CARLSON. Diagnosis and treatment of carcinoma of the lung.

MISSOURI BAPTIST HOSPITAL

Monday

- C. H. SHUTT—2 General surgery
 J. S. YOUNG—2 Radiology
 M. L. KLINEFELTER—2 Demonstration of pathologic fractures
 GEORGE IVES—3 Cytologic study of cancer
 R. M. KLEMM—3 Neurosurgery

Tuesday

- E. L. DORSETT—9 Gynecological operations
 M. L. KLINEFELTER—9 Bone and joint surgery
 J. E. GLENN—9 Genito-urinary surgery
 H. TALBOTT—9 General surgery
 W. BARTLETT and W. BARTLETT, JR.—9 Goiter surgery
 R. J. CROSSEN—2 Gynecology
 D. K. ROSE—2 Genito-urinary clinic.
 GEORGE IVES—2 Demonstration of method of blood transfusion
 W. E. WERNER—3 Goiter etiology

Wednesday

- C. H. SHUTT—9 General surgery
 M. L. KLINEFELTER—9 Bone and joint surgery
 C. E. BURFORD—9 Genito urinary surgery
 J. B. BROWN—9 Plastic surgery
 W. BARTLETT, W. BARTLETT, JR. and J. C. LYTER—9 General surgery
 R. K. ANDREWS, O. H. CAMPBELL, C. E. GILLILAND, L. R. HEMPLEMAN, S. D. GRANT, and J. C. LYTER—2 Internists' symposium on surgical failures
 C. E. BURFORD—2 Genito urinary surgery

Thursday

- R. S. KEIFFER—9 General surgery
 M. L. KLINEFELTER—9 Bone and joint surgery
 W. S. WIATT—9 General surgery
 D. K. ROSE—9 Genito urinary surgery
 W. BARTLETT and W. BARTLETT, JR.—9 Goiter surgery
 S. I. SCHWAB and W. BARTLETT—2 Psychiatric aspects of surgery
 S. B. GRANT—2 The heart in goiter cases
 J. P. ATLEHEIDE—2 Genito-urinary surgery
 J. B. BROWN—2 Industrial surgery
 J. P. MURPHY—3 The larynx in goiter cases
 J. S. YOUNG—3 Physiotherapy

Friday

- M. L. KLINEFELTER—9 Bone and joint surgery
 H. M. MOORE—9 General surgery
 Q. U. NEWELL—9 Gynecological operations
 R. M. KLEMM—9 Neurosurgical operations
 W. BARTLETT, JR.—9 General surgery
 W. L. CONRAD and H. F. D'OENCH—2 Dental surgery
 E. L. DORSETT—2 Gynecology
 W. BARTLETT, JR.—3 Chief safety factor in goiter surgery

LUTHERAN HOSPITAL

Monday

- T. P. BROOKES—2 Dislocations of the cervical spine, complications, demonstrations of cases, lantern slides and moving pictures

Tuesday

- H. L. NIETERT—9 General surgical operations.
 J. L. HUTTON, V. KLOEPPER and F. DEMKO—9 General surgical operations

Wednesday

- R. E. SCHLUETER and H. P. THYM—9 General surgical operations
 H. A. HANSEN, T. H. HANSEN, and A. G. KLEIN—9 General surgical operations with spinal anæsthesia
 H. A. HANSEN, T. H. HANSEN, and A. G. KLEIN—2 Embolectomy, demonstration of cases
 E. W. SPINZIG—3 Roentgenological diagnosis of spontaneous and traumatic pneumoperitoneum

Thursday

- J. L. HUTTON, V. KLOEPPER and F. DEMKO—9 General surgical operations
 H. L. NIETERT—9 General surgical operations
 H. G. LUND and JAMES O'DOWD—9 Urological operations

Friday

- H. A. HANSEN, T. H. HANSEN, and A. G. KLEIN—9 General surgical operations, spinal anæsthesia
 R. E. SCHLUETER and H. P. THYM—9 General surgical operations
 G. O. GAUEN and E. A. VOGEL—9 Obstetrical operations

DEACONESS HOSPITAL

Monday

- HERMAN NIETERT, FRANCIS REDEP, FRED BAILEY, JOHN C. MORFIT, ROBERT E. SCHLUETER and A. R. SHREFFLER—2 Medico-surgical dry clinics

Tuesday

- FRED W. BAILEY, WILLIAM H. NORTON, A. V. MARQUARDT, LEO A. WILL and J. EDGAR STEWART—9 General surgery and orthopedic operations
 A. R. SHREFFLER, EDWIN SCHISLER, M. L. KLINEFELTER, GUY SIMPSON, N. C. GAYLOR and DREW LUTEN—2 Medico-surgical clinical demonstrations

Thursday

- E. LEE DORSETT, N. C. GAYLOR, JOHN W. STEWART, FRED W. BAILEY, FRANCIS REDEP and HERMAN NIETERT—9 General surgical and gynecological operations
 L. H. HEMPLEMAN, LEO BROOKS, CLAUDE PICKRELL, CHARLES A. STONE, JOHN C. MORFIT, M. F. ARBUCKLE and FRED C. SIMON—2 Clinical demonstrations

MISSOURI PACIFIC HOSPITAL

Tuesday

- O. B. ZEINERT and associates—9 General surgical operations
 W. P. ELMER and associates—9 Medical diagnostic clinic

Wednesday

- I. H. BOEMER and associates—9 Abdominal surgery
 W. K. MUELLER and associates—9 Roentgenological clinic.
 H. J. SCHERCK and associates—9 Genito-urinary surgery

Thursday

- A. O. FISHER and associates—9 General surgical operations
 W. P. ELMER and associates—9 Medical diagnostic clinic

Friday

- O. B. ZEINERT and associates—9 General surgical operations
 W. K. MUELLER and associates—9 Roentgenological clinic.
 J. H. SANFORD and associates—9 Genito-urinary surgery

DEPAUL HOSPITAL

Tuesday

- EDWARD J. O'MALLEY and HENRY A. HANBETT—*g.* Surgical clinic, outpatient department
 FRANK TADDER, ROBERT E. SCHLUTTER and R. EMORY KANE—*g.* General surgical operations
 H. H. KRAMOLOWSKY—*g.* Genito-urinary clinic, moving pictures
 C. J. ALTHAUS—*g.* Genito-urinary operations
 ROBERT DEAN—*g.* Renal tuberculosis
 J. F. BRECKEN—*g.* Schilling differential count in surgical diagnosis
 L. D. CADDY—*g.* Postoperative neurones

Wednesday

- J. W. THOMPSON, ARTHUR GURIELLO, E. J. O'MALLEY and C. E. HYNDMAN—*g.* General surgical operations
 V. P. BLAIR, J. B. BROWN and W. S. HANBETT—*g.* Plastic surgery
 H. W. SCHER—*g.* Diathermy in benign and malignant lesions of rectum
 OLIVER ARRL, JR.—*g.* Estimating the cardiac factor in surgical risk
 CHARLES EYERMAN—*g.* Allergy in surgical diagnosis
 D. B. FLAVAN—*g.* Chemical electrocardiography
 T. WINTER WHITE—*g.* Pneumococcus peritonitis in children, differential diagnosis for appendicitis

Thursday

- A. J. GETTINGER and H. S. LAMBERS—*g.* General surgery
 C. A. STONE—*g.* Orthopedic surgery
 E. J. O'MALLEY and H. A. HANBETT—*g.* General surgical operations
 A. P. ROWLETT—*g.* Experiments on pyloric function and gastric acidity
 W. C. CONSON—*g.* Effect of irradiated ergosterol on blood coagulation
 F. R. FRIEDMAN—*g.* The effect of aldolase on cancer
 E. P. BUDOFF—*g.* Clinical demonstration
 W. G. BECKER—*g.* Surgery and diabetes

Friday

- L. M. RICHMAN, R. J. CHAMBER, F. P. McMALEY, L. E. PATTON, PEARCY SWANLEN and J. H. KIMCO—*g.* Gynecological operations
 V. P. BLAIR, J. B. BROWN and W. S. HANBETT—*g.* Plastic surgery
 L. D. CADDY—*g.* Differential diagnosis of lesions of colon
 J. W. THOMPSON—*g.* Carcinoma of colon, exhibition of cases
 F. R. FRIEDMAN—*g.* Carcinoma of esophagus, diagnosis and treatment

FRISCO EMPLOYEES' HOSPITAL

Wednesday

- R. A. WOOLERY—*g.* Back injuries and back conditions

Thursday

- R. A. WOOLERY—*g.* General surgical operations

U S VETERANS' HOSPITAL

Tuesday

- S. L. FILLERS—*g.* General surgical clinic
 J. E. WHEELER—*g.* Orthopedic clinic

ST LOUIS CITY HOSPITAL

Monday

- W. H. VOOT, PERCY H. SWANLEN, T. R. AYARS and W. J. HANBETT—*g.* Obstetrical clinic

Tuesday

- MAX W. MYER, CHARLES F. SHERWIN and HENRY HANBETT—*g.* General surgery
 W. J. DOYLE and J. J. LEVY—*g.* General surgery
 FRANCIS REIDER and THOMAS S. WICKER—*g.* Isolated and traumatic surgery, dry clinic
 GRAYSON CARROLL, GEORGE H. KIDDER and CLARENCE MARTIN—*g.* Genito-urinary clinic

Wednesday

- EDMUND RUED, WILLIAM STUDE and S. A. WIEDENBACH—*g.* Gynecological clinic
 H. H. HELLMAN, C. W. GARDNER, A. V. MARQUANT and W. H. CLEGG—*g.* Gynecological clinic
 JOHN W. STEWART, A. E. HORWITZ and E. L. MORSE—*g.* Fractures, dry clinic

Thursday

- JOHN W. STEWART and J. L. FERRIS—*g.* General surgery
 FRANCIS REIDER, J. W. THOMPSON and RICHARD S. KETTER—*g.* General surgery
 FRANK J. TADDER, WALTER C. G. KIRCHNER and W. J. DOYLE—*g.* Penetrating wounds of the chest and abdomen, dry clinic
 H. H. KRAMOLOWSKY and BENJAMIN F. MAY—*g.* Genito-urinary clinic
 H. G. LUND and P. N. DAVIS—*g.* Genito-urinary clinic

Friday

- FRANK J. TADDER and W. J. GALLAGHER—*g.* General surgery
 THOMAS S. WICKER and N. M. FERRIS—*g.* General surgery
 CHARLES F. SHERWIN and LEROY SENTER—*g.* Surgical and radiological treatment of cancer, dry clinic

ST LUKE'S HOSPITAL

Tuesday

- J. H. BARFORD, JOHN R. CAULE, OTTO WILHELM, JOHN PATTON and C. E. ROEPER—*g.* Genito-urinary surgery
 D. STUTTMAN—*g.* Genito-urinary clinic
 J. H. BARFORD—*g.* Diagnosis and treatment of kidney lesions
 O. C. ZINK—*g.* X-ray interpretation
 R. M. KIDDER—*g.* Brain abscess

Wednesday

- C. D. O'KEEFE, OTTO KIRKE, ROBERT CHOMER and EDGAR SCHMIDT—*g.* Gynecological operations
 J. V. DUNN and GARY JONES—*g.* Obstetrical and gynecological clinic
 C. D. O'KEEFE—*g.* Ovarian cysts
 OTTO KIRKE—*g.* Sterility

Thursday

- R. M. KIDDER—*g.* Neurological surgery
 A. O'REILLY and J. E. STEWART—*g.* Orthopedic surgery
 J. E. STEWART—*g.* Orthopedic clinic
 J. E. STEWART—*g.* Fractures of upper third of femur
 O. C. ZINK—*g.* X-ray demonstration

Friday

- O. R. SEVIN—*g.* General surgery
 L. KETTER, C. E. HYNDMAN, E. V. MARTIN and E. K. DEDON—*g.* General surgical clinic

SURGERY OF THE EYE, EAR, NOSE, AND THROAT

WASHINGTON UNIVERSITY MEDICAL SCHOOL

McMILLAN HOSPITAL

Daily, 9 00 and 10 30

Staff—Clinical lectures and demonstrations

LAWRENCE T POST Slit lamp demonstration
 WILLIAM E SHAHAN Physiological apparatus (including thermophore)
 WILLIAM F HARDY Ocular muscles
 H ROMMEL HILDRETH Ultraviolet light therapy
 B Y ALVIS Cylinder skiascopy
 M HAYWARD POST Advanced refraction technique
 FREDERICK E WOODRUFF Ophthalmoscopy
 MAX W JACOBS Ocular changes during pregnancy
 J T JENNINGS Color vision tests
 ROY L MASON Industrial ophthalmology

Monday

HOWARD C KNAPP—2 Ocular tuberculosis clinic
 MEYER WIENER—2 Diagnostic eye clinic
 WILLIAM M JAMES—3 Ocular syphilis clinic.
 F K HANSEL—2 Allergic clinic.
 C C BUNCH—2 Hearing tests
 H W LYMAN—2 Vestibular tests
 H N GLICK, HELEN GAGE, ALLEN POTTER, and L C BOEMER—3 Otolaryngological diagnostic clinic
 L W DEAN—4 Demonstration of cases illustrating laboratory methods used in diagnosis

Tuesday

M HAYWARD POST—2 Diagnostic eye clinic
 F K HANSEL—2 Allergic clinic
 C C BUNCH—2 Hearing tests
 H W LYMAN—2 Vestibular tests
 H N GLICK, HELEN GAGE, ALLEN POTTER, and L C BOEMER—3 Otolaryngological diagnostic clinic
 I Y OLCH and CLIFFORD MENZIES—4 Demonstration of cases, pathology of ear, nose and throat

Wednesday

HOWARD C KNAPP—2 Ocular tuberculosis clinic
 WILLIAM E SHAHAN—2 Diagnostic eye clinic
 WILLIAM M JAMES—3 Ocular syphilis clinic
 F K HANSEL—2 Allergic clinic
 C C BUNCH—2 Hearing tests
 H W LYMAN—2 Vestibular tests
 H N GLICK, HELEN GAGE, ALLEN POTTER, and L C BOEMER—3 Otolaryngological diagnostic clinic
 L K GUGGENHEIM and DOROTHY WOLFF—4. Embryology and anatomy of ear, nose and throat

Thursday

WILLIAM F HARDY—2 Diagnostic eye clinic
 HARVEY J HOWARD—3 Conference in ophthalmology
 F K HANSEL—2 Allergic clinic
 C C BUNCH—2 Hearing tests
 H W LYMAN—2 Vestibular tests
 H N GLICK, HELEN GAGE, ALLEN POTTER, and L C BOEMER—3 Otolaryngological diagnostic clinic.
 C C BUNCH—4 Cases with audiometric curves

Friday

HOWARD C KNAPP—2 Ocular tuberculosis clinic
 LAWRENCE T POST—2 Diagnostic eye clinic
 WILLIAM M JAMES—3 Ocular syphilis clinic.
 F K HANSEL—2 Allergic clinic
 C C BUNCH—2 Hearing tests.
 H N GLICK, HELEN GAGE, ALLEN POTTER and L C BOEMER—3 Otolaryngological diagnostic clinic

OSCAR JOHNSON INSTITUTE

Staff—Daily, 9 00 and 10 30, Laboratory demonstrations

HARVEY D LAMB Pathology of the eye
 WILLIAM M JAMES Conjunctival cytology
 H ROMMEL HILDRETH Anatomy of eye and orbit.
 GEORGE H BISHOP and B HOWARD BARTLEY Physiology of the eye
 PERCY W COBB Physiological optics
 CHARLOTTE WEIGHARD Chemistry relating to ophthalmology
 ROSSLENE A HETLER Nutrition relating to ophthalmology
 LOUIS A JULIANELLE and MARION C MORRIS Bacteriology of the eye

Staff—Daily, 2 00 Laboratory demonstrations, otolaryngology

GEORGE E HOURS, LOUIS J BIRSNER, JAMES B COSTEN, HARRY N GLICK, I D KELLEY, JR and DOROTHY WOLFF Anatomy
 W F WENNER and P R NEMOURS Physiology
 CATHERINE BUHRMESTER Chemistry
 EVELYN DIXON Bacteriology
 L W DEAN Cytology
 A J CONE Temperature changes
 LOUIS K GUGGENHEIM Embryology
 B J McMAHON and CLIFFORD MENZIES Pathological studies

ST LOUIS CHILDREN'S HOSPITAL

Tuesday

L E FREIMUTH—11 Otolaryngological operations

Friday

G E HOURS—9 Otolaryngological operations.
 A M ALDEN—11 Otolaryngological operations

BARNES HOSPITAL

Monday

FREDERICK O SCHWARTZ—2 Ophthalmological operations, strabismus

Tuesday

L W DEAN and staff—9 Diagnostic clinic
 M F ARBUCKLE and B J McMAHON—11 Otolaryngological operations
 MEYER WIENER—2 Ophthalmological operations

Wednesday

L W DEAN and staff—9 Diagnostic clinic.
 HARVEY J HOWARD—2 Ophthalmological operations, demonstrating akinesia, scleroconjunctiva suture, in tracapsular cataract extraction

Thursday

H W LYMAN, I D KELLEY, JR.—9 Otolaryngological operations

Friday

A J CONE, and J B COSTEN—9 Otolaryngological operations
 W L HANSON, L J BIRSNER and F K HANSEL—11 Otolaryngological operations
 H. ROMMEL HILDRETH—2 Plastic surgery of the eye

SURGERY GYNECOLOGY AND OBSTETRICS

SHRINERS' HOSPITAL

Tuesday

- C. H. CARR—*a*. Operative lengthening of tibia and fibula
C. H. CARR—*a*. Leg lengthening cases, end-results

Wednesday

- J. B. BARNES—*a*. End-results after split thickness skin grafts
Staff—*a*. Orthopedic end-results

Thursday

- C. H. CARR—*a*. Orthopedic operations.
J. A. KIRK—*a*. Orthopedic clinic.

ROBERT KOCH HOSPITAL

Wednesday

- Staff—*a*. Dry clinic. H. I. SEACON. Diagnosis and treatment of pneumoconiosis complicated by pulmonary tuberculosis. DOTT S. ALLAN and GEORGE KERRICK. Surgical treatment of bilateral pulmonary tuberculosis; partial apical thoracoplasty versus phre-

nectomy in pulmonary tuberculosis. A. E. ROBERT. Subtrochanteric osteotomy for contracted hip deformity. GEORGE S. WILLIAMS. Schilling blood count in respect to the surgical treatment of pulmonary tuberculosis. RALPH ESKINER. Artificial pneumothorax in the treatment of pulmonary tuberculosis in the negro.

U S MARINE HOSPITAL

Monday

- J. E. SMITH—*a*. Clinical demonstration of abscess of lung

Tuesday

- W. M. JONES—*a*. General surgical operations.
W. L. CONN—*a*. Clinical demonstration of abdominal tumor with obstruction of transverse colon.

Thursday

- W. M. JONES—*a*. General surgical operations.
J. T. DILLON—*a*. Clinical demonstration of pyloric obstruction of stomach.

Friday

- W. M. JONES—*a*. General surgical operations.

SURGERY OF THE EYE, EAR, NOSE, AND THROAT

WASHINGTON UNIVERSITY MEDICAL SCHOOL

McMILLAN HOSPITAL

Daily, 9 00 and 10 30

Staff—Clinical lectures and demonstrations

- LAWRENCE T POST Slit lamp demonstration
- WILLIAM E SHAHAN Physiological apparatus (including thermophore)
- WILLIAM F HARDY Ocular muscles
- H ROMMEL HILDRETH Ultraviolet light therapy
- B Y ALVIS Cylinder skiascopy
- M HAYWARD POST Advanced refraction technique
- FREDERICK E WOODRUFF Ophthalmoscopy
- MAX W JACOBS Ocular changes during pregnancy
- J E JENNINGS Color vision tests
- ROY L MASON Industrial ophthalmology

Monday

- HOWARD C KNAPP—2 Ocular tuberculosis clinic
- MEYER WIENER—2 Diagnostic eye clinic.
- WILLIAM M JAMES—3 Ocular syphilis clinic
- F K HANSEL—2 Allergic clinic
- C C BUNCH—2 Hearing tests
- H W LYMAN—2 Vestibular tests
- H N GLICK, HELEN GAGE, ALLEN POTTER, and L C BOEMER—3 Otolaryngological diagnostic clinic
- L W DEAN—4 Demonstration of cases illustrating laboratory methods used in diagnosis

Tuesday

- M HAYWARD POST—2 Diagnostic eye clinic
- F K HANSEL—2 Allergic clinic.
- C C BUNCH—2 Hearing tests
- H W LYMAN—2 Vestibular tests
- H N GLICK, HELEN GAGE, ALLEN POTTER, and L C BOEMER—3 Otolaryngological diagnostic clinic
- I Y OLCH and CLIFFORD MENZIES—4 Demonstration of cases, pathology of ear, nose and throat.

Wednesday

- HOWARD C KNAPP—2 Ocular tuberculosis clinic
- WILLIAM E SHAHAN—2 Diagnostic eye clinic
- WILLIAM M JAMES—3 Ocular syphilis clinic
- F K HANSEL—2 Allergic clinic
- C C BUNCH—2 Hearing tests
- H W LYMAN—2 Vestibular tests
- H N GLICK, HELEN GAGE, ALLEN POTTER, and L C BOEMER—3 Otolaryngological diagnostic clinic
- L K GUGGENHEIM and DOROTHY WOLFF—4 Embryology and anatomy of ear, nose and throat

Thursday

- WILLIAM F HARDY—2 Diagnostic eye clinic
- HARVEY J HOWARD—3 Conference in ophthalmology
- F K HANSEL—2 Allergic clinic
- C C BUNCH—2 Hearing tests
- H W LYMAN—2 Vestibular tests
- H N GLICK, HELEN GAGE, ALLEN POTTER, and L C BOEMER—3 Otolaryngological diagnostic clinic.
- C C BUNCH—4 Cases with audiometric curves

Friday

- HOWARD C KNAPP—2 Ocular tuberculosis clinic
- LAWRENCE T POST—2 Diagnostic eye clinic
- WILLIAM M JAMES—3 Ocular syphilis clinic.
- F K HANSEL—2 Allergic clinic
- C C BUNCH—2 Hearing tests.
- H N GLICK, HELEN GAGE, ALLEN POTTER and L C BOEMER—3 Otolaryngological diagnostic clinic.

OSCAR JOHNSON INSTITUTE

Staff—Daily, 9 00 and 10 30, Laboratory demonstrations

- HARVEY D LAMB Pathology of the eye
- WILLIAM M JAMES Conjunctival cytology
- H ROMMEL HILDRETH Anatomy of eye and orbit.
- GEORGE H BISHOP and B HOWARD BARTLEY Physiology of the eye
- PERCY W COBB Physiological optics
- CHARLOTTE WEIGHARD Chemistry relating to ophthalmology
- ROSSLENE A HETLER Nutrition relating to ophthalmology
- LOUIS A JULIANELLE and MARION C MORRIS Bacteriology of the eye

Staff—Daily, 2 00 Laboratory demonstrations, otolaryngology

- GEORGE L HOURN, LOUIS J BIRSNER, JAMES B COSTEN, HARRY N GLICK, I D KELLEY, JR. and DOROTHY WOLFF Anatomy
- W F WENNER and P R NEMOURS Physiology
- CATHERINE BUHRMESTER Chemistry
- EVELYN DIXON Bacteriology
- L W DEAN Cytology
- A J CONE Temperature changes
- LOUIS K GUGGENHEIM Embryology
- B J McMAHON and CLIFFORD MENZIES Pathological studies

ST LOUIS CHILDREN'S HOSPITAL

Tuesday

- L E FREIMUTH—11 Otolaryngological operations

Friday

- G E HOURN—9 Otolaryngological operations
- A M ALDEN—11 Otolaryngological operations

BARNES HOSPITAL

Monday

- FREDERICK O SCHWARTZ—2 Ophthalmological operations, strabismus

Tuesday

- L W DEAN and staff—9 Diagnostic clinic.
- M F ARBUCKLE and B J McMAHON—11 Otolaryngological operations
- MEYER WIENER—2 Ophthalmological operations

Wednesday

- L W DEAN and staff—9 Diagnostic clinic.
- HARVEY J HOWARD—2 Ophthalmological operations, demonstrating akinesia, scleroconjunctiva suture, in tracapsular cataract extraction

Thursday

- H W LYMAN, I D KELLEY, JR.—9 Otolaryngological operations

Friday

- A J CONE, and J B COSTEN—9 Otolaryngological operations
- W L HANSON, L J BIRSNER and F K HANSEL—11 Otolaryngological operations
- H. ROMMEL HILDRETH—2 Plastic surgery of the eye

SHRDNERS' HOSPITAL

Tuesday

- C. H. CASCO—9. Operative lengthening of tibia and fibula.
C. H. CASCO—2. Leg lengthening cases, end-results

Wednesday

- J. B. BROWN—9. End-results after split thickness skin grafts.
Staff—2. Orthopedic end-results.

Thursday

- C. H. CASCO—9. Orthopedic operations.
J. A. KEE—2. Orthopedic clinic.

ROBERT KOCH HOSPITAL

Wednesday

- Staff— Dry clinic. H. I. SPECTOR. Diagnosis and treatment of pneumoconiosis complicated by pulmonary tuberculosis. DUFF S. ALLEN and GEORGE KITTLE KAMP. Surgical treatment of bilateral pulmonary tuberculosis. partial apical thoracoplasty versus phre-

nectomy in pulmonary tuberculosis. A. E. HOSKIN. Subtrochanteric osteotomy for contracture hip deformity. GEORGE S. WILSON. Schilling blood count in respect to the surgical treatment of pulmonary tuberculosis. RALPH EMMERT. Artificial pneumothorax in the treatment of pulmonary tuberculosis in the negro.

U. S. MARINE HOSPITAL

Monday

- J. E. SMITH—2. Clinical demonstration of abscess of leg.

Tuesday

- W. M. JONES—6. General surgical operations.
W. L. CONRY—2. Clinical demonstration of sigmoid tumor with obstruction of transverse colon.

Thursday

- W. M. JONES—10. General surgical operations.
J. T. DISLOUTUNSKY—2. Clinical demonstration of pyloric obstruction of stomach.

Friday

- W. M. JONES—10. General surgical operations.

SURGERY OF THE EYE, EAR, NOSE, AND THROAT WASHINGTON UNIVERSITY MEDICAL SCHOOL

McMILLAN HOSPITAL

Daily, 9 00 and 10 30

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B Y ALVIS Cylinder skiascopy

M HAYWARD POST Advanced refraction technique

FREDERICK E WOODRUFF Ophthalmoscopy

MAX W JACOBS Ocular changes during pregnancy

J L JENNINGS Color vision tests

ROY L MASON Industrial ophthalmology

Monday

HOWARD C KNAPP—2 Ocular tuberculosis clinic.

MEYER WIENER—2 Diagnostic eye clinic

WILLIAM M JAMES—3 Ocular syphilis clinic

F K HANSEL—2 Allergic clinic

C C BUNCH—2 Hearing tests

H W LYMAN—2 Vestibular tests

H N GLICK, HELEN GAGE, ALLEN POTTER, and L C

BOEMER—3 Otolaryngological diagnostic clinic

L W DEAN—4 Demonstration of cases illustrating laboratory methods used in diagnosis

Tuesday

M HAYWARD POST—2 Diagnostic eye clinic

F K HANSEL—2 Allergic clinic.

C C BUNCH—2 Hearing tests

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I Y OLCH and CLIFFORD MENZIES—4 Demonstration of cases, pathology of ear, nose and throat

Wednesday

HOWARD C KNAPP—2 Ocular tuberculosis clinic

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F K HANSEL—2 Allergic clinic

C C BUNCH—2 Hearing tests

H W LYMAN—2 Vestibular tests

H N GLICK, HELEN GAGE, ALLEN POTTER, and L C

BOEMER—3 Otolaryngological diagnostic clinic

L K GUGGENHEIM and DOROTHY WOLFF—4 Embryology and anatomy of ear, nose and throat

Thursday

WILLIAM F HARDY—2 Diagnostic eye clinic

HARVEY J HOWARD—3 Conference in ophthalmology

F K HANSEL—2 Allergic clinic.

C C BUNCH—2 Hearing tests

H W LYMAN—2 Vestibular tests

H N GLICK, HELEN GAGE, ALLEN POTTER, and L C

BOEMER—3 Otolaryngological diagnostic clinic

C C BUNCH—4. Cases with audiometric curves

Friday

HOWARD C KNAPP—2 Ocular tuberculosis clinic

LAWRENCE T POST—2 Diagnostic eye clinic

WILLIAM M JAMES—3 Ocular syphilis clinic.

F K HANSEL—2 Allergic clinic

C C BUNCH—2 Hearing tests.

H N GLICK, HELEN GAGE, ALLEN POTTER and L C

BOEMER—3 Otolaryngological diagnostic clinic.

OSCAR JOHNSON INSTITUTE

Staff—Daily, 9 00 and 10 30, Laboratory demonstrations

HARVEY D LAMB Pathology of the eye

WILLIAM M JAMES Conjunctival cytology

H ROMMEL HILDRETH Anatomy of eye and orbit

GEORGE H BISHOP and B HOWARD BARTLEY

Physiology of the eye.

PERCY W COBB Physiological optics

CHARLOTTE WEIGHARD Chemistry relating to ophthalmology

ROSSLEENE A HETLER Nutrition relating to ophthalmology

LOUIS A JULIANELLE and MARION C MORRIS Bacteriology of the eye.

Staff—Daily, 2 00 Laboratory demonstrations, otolaryngology

GEORGE E HOURN, LOUIS J BIRSNER, JAMES B

COSTEN, HARRY N GLICK, I D KELLEY, JR.

and DOPOTHY WOLFF Anatomy

W F WENNER and P R NEMOURS Physiology

CATHERINE BUHRMESTER Chemistry

EVELYN DIXON Bacteriology

L W DEAN Cytology

A J CONE Temperature changes

LOUIS K GUGGENHEIM Embryology

B J McMAHON and CLIFFORD MENZIES Pathological studies

ST LOUIS CHILDREN'S HOSPITAL

Tuesday

L E FREIMUTH—11 Otolaryngological operations.

Friday

G E HOURN—9 Otolaryngological operations

A M ALDEN—11 Otolaryngological operations

BARNES HOSPITAL

Monday

FREDERICK O SCHWARTZ—2 Ophthalmological operations, strabismus

Tuesday

L W DEAN and staff—9 Diagnostic clinic.

M F ARBUCKLE and B J McMAHON—11 Otolaryngological operations

MEYER WIENER—2 Ophthalmological operations

Wednesday

L W DEAN and staff—9 Diagnostic clinic.

HARVEY J HOWARD—2 Ophthalmological operations, demonstrating akinesia, scleroconjunctiva suture, intracapsular cataract extraction

Thursday

H W LYMAN, I D KELLEY, JR—9 Otolaryngological operations

Friday

A J CONE, and J B COSTEN—9 Otolaryngological operations

W L HANSON, L J BIRSNER and F K HANSEL—11 Otolaryngological operations

H. ROMMEL HILDRETH—2 Plastic surgery of the eye

CENTRAL INSTITUTE FOR THE DEAF

Wednesday and Thursday

- MAX A. GOLDSTEIN, JULIA M. CONROY and Staff—10. Recent developments in the training of the deaf child, pre-school deaf child, the first instruction in speech and lip-reading; conservation of residual hearing: a play by deaf children, the end products of training.
- MILDRED A. MCGOON and staff—10. The operation of

a clinic for the correction of defects in speech. A demonstration of selected types of cases.

- HELEN M. GERRARD and VIVIAN GROSS—10. Practical accomplishments in lip-reading.
- R. LORENTE DE NO, HELEN F. SCHICK and MAX A. GOLDSTEIN—11. Some phases of special laboratory research in neuro-anatomy, phonetics, acoustics and psychology as applied at Central Institute for the Deaf.

ST LOUIS UNIVERSITY MEDICAL SCHOOL

FIRMEN DESLOGE HOSPITAL

Tuesday

- JOHN GREEN—2. Local use of epinephrin and epinephrin substitutes as adjuncts to anasthetics in the treatment of glaucoma, strabismus, with demonstrations.
- J. F. HARGREAVE—3.30. Immediate reduction of intra-ocular hypertension by constitutional treatment, with clinical demonstrations.
- M. L. GRIFFIN—3. Winged keratotomy with basal iridectomy for acute or chronic glaucoma, Luedde operation, with demonstrations and review of results.
- ALBERT KURTZ—3.30. Fundamental principles in neurological and mechanical control of intra-ocular pressure.

Wednesday

- W. H. LUTKRE—2. The new Blagden-Chandrasekhar super-giant magnet.
- M. L. GRIFFIN—3.35. The giant magnet in ophthalmic practice; experimental tests showing its wide range of power; suggestions for its use in laryngology and bronchology.
- W. E. LUTKRE—3. Usefulness of giant magnet in surgery with experimental demonstrations.
- H. COO. RANK—3.30. Ocular by-products in industrial surgery.

Thursday

- ERNEST T. SHERIDAN—2. Otolaryngological operations.
- LAURA LAMM (by invitation)—2. Ocular tumors, with demonstrations from Wintersteiner collection.
- J. M. KELLER and C. J. QUINN—30. Ocular tumors, with demonstrations from Wintersteiner collection.
- JOSEPH MUELLER (Heldberg, Germany)—3. Sympathetic ophthalmia, with demonstrations from Wintersteiner collection.
- CARL T. EBER—3.30. Moving picture demonstration. Cataract operations, Luedde technique for glaucoma operation.
- W. H. LUTKRE—3.45. Successful destruction of intra-ocular pigmented new growth by localized controlled heat (Shaban thermoprobe). Demonstration of unique case after four years.

Friday

- L. C. DREWS—2. Serological control of retinitis pigmentosa, review of clinical evidence.
- R. L. JONES and FRANCIS J. ROSSER—30. Preparation and distribution of ocular extract for retinitis pigmentosa.
- W. H. LUTKRE—3. Surgical significance of mechanical factors in ocular accommodation, mechanical factors in progressive myopia and their control presentation of cases.
- CARL T. EBER—3.30. Moving picture demonstration. Cataract operations, Luedde techniques for glaucoma operations.

ST MARY'S HOSPITAL

Monday

- W. E. SAUER, S. B. WESTLAKE, R. H. MILLMAN and C. O. BROWN—2. Otolaryngological operations.
- WILLIAM H. LUTKRE, JOHN GREEN and associates—2. Ophthalmological clinic.
- C. E. RICE—2. Surgical treatment of trachoma.

Tuesday

- C. E. RICE—2. Surgical treatment of trachoma.

Wednesday

- JOHN GREEN and associates—2. Ophthalmological clinic.

Thursday

- W. E. SAUER, S. B. WESTLAKE, R. H. MILLMAN and C. O. BROWN—2. Otolaryngological operations.

ST JOHN'S HOSPITAL

Tuesday

- E. P. NORTH, V. L. JONES, N. R. DODDILL and JOHN McGRATH—2. Demonstration of ophthalmological cases.
- C. F. PRIDMORE—2. Otolaryngological operations.

Thursday

- V. V. WOOD— Demonstration of otolaryngological cases.

Friday

- V. V. WOOD and ELMER SCHULTZ—9. Otolaryngological operations.

ST ANTHONY'S HOSPITAL

Monday

- F. G. A. BARDONCKE—2. Otolaryngological operations.
- C. J. QUINN—2. Ophthalmological clinic, operations and demonstration of cases.

Wednesday

- J. M. KELLER— Ophthalmological clinic, operations and demonstration of cases.

Friday

- F. G. A. BARDONCKE —2. Otolaryngological operations.

ST MARY'S INFIRMARY

Tuesday

- WILLIAM E. SAUER—2. Aural surgery.

Wednesday

- J. F. HARGREAVE and associates—2. Ophthalmological clinic.

ALEXIAN BROTHERS HOSPITAL

Monday

J M KELLER—3 Ophthalmological clinic

Tuesday

D P FERRIS—2 Otolaryngological clinic.

Wednesday

C J GISSY—3 Ophthalmological clinic.

JEWISH HOSPITAL

Monday

EUGENE T SENSENEY—2 Radical mastoidectomy
 I D KELLEY, JR—2 Direct vision adenectomy
 A. M. ALDEN—2 Classic closure of mastoid fistula

Tuesday

MAX W JACOBS and B Y ALVIS—2 Ophthalmological clinic, operations and demonstration of cases

Wednesday

E LEE MYERS and staff—2 Demonstration of bronchoscopy cases, laryngectomy
 C E EIMER—2 Direct laryngoscopy examination (Haslinger)
 I D KELLEY, JR—2 Lynch suspension
 M D PELZ, O R DOBBS and MAXWELL FINEBERG—2 Diagnostic clinic with demonstration of cases

Thursday

MEYER WIENER—2 Ophthalmological operations

Friday

LOUIS K GUGGENHEIM—2 Demonstration of cases
 A. M. ALDEN—2 Snare and guillotine tonsillectomy and demonstration of ligation of bleeder, dacryorhinocystotomy
 S B WESTLAKE—2 Radical mastoidectomy

DEPAUL HOSPITAL

Tuesday

V V WOOD—2 Otolaryngological operations
 L J BIRNBER—2 Anatomy of neck in relation to deep infections originating in throat and their surgical treatment.
 W P DONOVAN—2 Otolaryngological operations

Wednesday

T P LAWTON—2 Otolaryngological operations
 GEORGE HOURN—2 Otolaryngological operations

Thursday

W E SAUER—2 Otolaryngological operations
 V V WOOD—2 Otolaryngological operations
 W P DONOVAN—2 Otolaryngological operations
 G H POOS—2 Ophthalmological operations

ST LOUIS CITY HOSPITAL

Tuesday

CARL T EBER—2 Ophthalmological operations
 E LEE MYERS—2 Otolaryngological operations

Friday

E LEE MYERS—2 Otolaryngological operations

Thursday

D P FERRIS—2 Otolaryngological clinic

MOUNT ST ROSE SANITARIUM

Wednesday

WILLIAM SMIT—2 30 Otolaryngological clinic

Friday

WILLIAM SMIT—2 30 Otolaryngological clinic.

ST LOUIS COUNTY HOSPITAL

Monday

O W KOCH, J B COSTEN and A M ALDEN—2 Otolaryngological operations

Wednesday

C P DYER, WILLIAM F HARDY and JOHN McGRATH—2 Ophthalmological operations and demonstration of cases

Friday

JOHN GREEN and CARL BEISBARTH—2 Ophthalmological operations

MISSOURI PACIFIC HOSPITAL

Tuesday

W G PATTON and associates—2 Otolaryngological operations

Wednesday

EMMETT P NORTH and VINCENT L JONES—2 Ophthalmology, diagnostic and operative clinic
 S B WESTLAKE and associates—2 Otolaryngological operations

Thursday

W G PATTON and associates—2 Otolaryngological operations

Friday

W G PATTON and associates—2 Otolaryngological operations

LUTHERAN HOSPITAL

Tuesday

F C SIMON—2 Otolaryngological operations
 H N GLICK—3 Surgical consideration of structure of petrous pyramid, demonstration of specimen, lantern slides

Wednesday

A HOOS—2 Eye operations

Thursday

F C SIMON—Otolaryngological operations
 FREDERICK O SCHWARTZ—2 Eye operations

ST LUKE'S HOSPITAL

Monday

W E SHAHAN—2 Ophthalmological operations

Tuesday

B J McMAHON—2 Otolaryngological operations

Thursday

B J McMAHON—2 Otolaryngological diagnostic clinic.

MISSOURI BAPTIST HOSPITAL

Monday

R. J. PAYNE—2. Otolaryngological operations.
H. N. GLOCK—2. Otolaryngological operations.

Tuesday

R. J. PAYNE—2. Otolaryngological operations.
H. N. GLOCK—2. Otolaryngological operations.
J. F. HANDESTEY—2. Ophthalmological operations.

U. S. VETERANS' HOSPITAL

Tuesday

P. H. GIBSON—1. Ophthalmological and otolaryngological clinic.

DEACONESS HOSPITAL

Monday

V. V. WOOD—2. Otolaryngological clinic.
F. C. SMOOK—2. Otolaryngological operations.

Tuesday

V. V. WOOD—2. Otolaryngological clinic.
F. C. SMOOK—2. Otolaryngological operations.

SAN FRANCISCO EMPLOYEES HOSPITAL

Tuesday

RICHARD J. PAYNE—2. Pulmonary lavage.
J. ELLIS JENNISON—3. Practical tests for color blindness; several color blind persons will be examined.

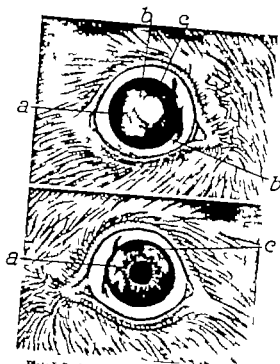


Plate I. In the upper plate the ovarian transplant *a*, is shown 7 hours after injection of cubic centimeters of urine obtained from a weeks' pregnancy. The developing follicles are well shown at *b b*. The endometrial tissue, is beginning to change from the bluish to the pink phase. The bluish is more advanced in the lower plate at *b*. The ovarian transplant, *a*, in this eye has not responded to stimulation as has the one in the opposite eye.

Physiological Responses of Ectopic Ovarian and Endometrial Tissue —
Edward Allen and Fred O. Priest

SURGERY, GYNECOLOGY AND OBSTETRICS

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NOVEMBER, 1932

NUMBER 5

PHYSIOLOGICAL RESPONSES OF ECTOPIC OVARIAN AND ENDOMETRIAL TISSUE

EDWARD ALLEN, M D , F A C S , AND FRED O PRIEST, M D , CHICAGO

From the Department of Obstetrics and Gynecology Rush Medical College of the University of Chicago and Presbyterian Hospital, Chicago

IN previous studies on the comparative growth of various pelvic tissues transplanted into the anterior chamber of the eye we were impressed by the possibilities offered for a study of function by direct observation. The preliminary work concerned itself only with the macroscopic and microscopic picture of growth. These observations have been continued and further verified. In addition we have included a study of physiological responses under the following headings:

- 1 (a) Recovery of normally impregnated ova from the uterus with attempted implantation into the abdominal cavity, (b) transplantation of this active ovarian tissue to the anterior chamber of the eye

- 2 Transplantation of normally fertilized ova to the anterior chamber of the eye

- 3 Physiological and artificial stimulation of ovulation

- 4 Direct observation of the effects of hormones

- 5 Attempts at fertilization of ova which had been produced by artificial stimulation

- 6 The possibility of the use of ovarian transplants in the eye as a test for pregnancy

Procedure Rabbits were used as the experimental animals. Bits of ovarian and endometrial tissue were removed by laparotomy and transplanted directly into the anterior chamber of the eye through an incision at the limbus. Sixty-eight animals were used.

Results The results will be described under the various headings previously listed.

1a Recovery of normally impregnated ova from the uterus with attempted implantation into the abdominal cavity In this series 34 rabbits were used. Twenty-eight previously isolated does were placed with the buck and then at periods varying from 72 to 140 hours after definitely observed coitus laparotomy was performed. The ovaries were inspected for signs of recent ovulation. One ovary, both of the tubes, and the entire uterus were removed and various transplants were made as described in the succeeding paragraphs. In 17 animals, the ova were washed from the uterus with warm normal saline or Locke's solution into a sterile watch glass, identified, and returned to the abdominal cavity. In the remainder the ova were washed back into the abdominal cavity directly from the uterus. Some of these eggs were saved for section and were shown to have been fertilized, since they were in the process of division. The number of eggs varied from one to nine. We could find no evidence of implantation of the ova that we had washed back into the abdominal cavity at subsequent operation or autopsy. We think we may be able to produce abdominal pregnancy by a modification of technic.

1b. Transplantation of this active ovarian tissue to the anterior chamber of the eye A small piece of the endometrium was transplanted

into the left eye, a thin section of ovary into both eyes (Fig. 1). The remaining ovary was left undisturbed in the abdomen. In none of these eyes observed from 3 days to as long as 7 months was ovulation noted. Schochet, in 1920 briefly reported ovulation in the eye of the rat. He failed to describe the details of his technique.

3 *Transplantation of normally fertilized ova to the anterior chamber of the eye.* Attempts were made in three animals to transplant normally fertilized ova recovered from uterine washings to an endometrial bed in the eye. The attempts to secure implantation were unsuccessful and we abandoned further efforts to implant ova hoping to produce ovulation in the eye and fertilize the ova there.

3 *Physiological and artificial stimulation of ovulation.* Ten of these rabbits were again placed with the buck and copulation observed between 3 weeks and 4 months after the preparatory operation described earlier. No evidence of ovulation in the eye was noted. The same rabbits were later given pregnant urine following the technique of the routine Friedman test. The abdominal ovary gave positive results in each instance but no evidence of ovulation was noted in the transplanted ovarian tissue.

We then thought that the reaction was a quantitative one and that possibly a concentrated hormone might produce results in the transplants. Two rabbits were prepared as follows. The right ovary and a small section of the right horn of the uterus were removed. Pieces of ovary and endometrium were transplanted into each eye. These 2 rabbits with the 10 already mentioned were given folliculin¹ or antuitrin S. Reaction in the transplanted ovarian tissue did not occur in any of the 12 rabbits. However extreme changes occurred in the abdominal ovaries of all rabbits and eggs were recovered from the unoperated upon horn of the uteri of the 2 rabbits prepared by the technique last mentioned.

4 *Direct observation of the effects of hormones.* The results thus far had suggested that the ovarian transplants were inactive and for this reason unresponsive to stimuli

of proved potency. The endometrial transplants in the eye continued to show the typical blush and blanch phenomenon which were recently described by Markee and which he says will disappear between 30 and 60 days after castration. This blush and blanch phenomenon was beautifully illustrated in many of our animals. We found as did Markee that it was not synchronous in multiple implants in the same eye or in opposite eyes. The rhythm was variable but we have not made careful observations as to its duration or the effect of the estrus cycle. Castration, then, seemed to us a logical measure to prove the viability of the transplanted ovarian tissue. The remaining ovary was removed and observations begun on the cyclic phenomenon of the transplanted endometrium. It did not disappear in most instances so we were forced to conclude that the ovarian transplants were active or that the congestion and blanching were under other control.

Thus far only two of these castrates have shown any spontaneous activity in the ovarian transplant. In one of these animals on the third day after castration, a suggestive spot appeared on the ovarian transplant, was very definite by the sixth day and continued to grow for 12 days. Spontaneous growth of follicles seemed to be a slower process than when it was precipitated by artificial stimulation such as pregnant urine. Complete regression occurred at the end of 12 additional days. The transplant in this rabbit was later stimulated by the intravenous injection of pregnant urine. After 48 hours macroscopic evidences of ovulation had occurred. The second animal also exhibited a small follicle-like spot in the ectopic ovarian tissue 3 days after castration. This spot became progressively darker and at the end of 7 days assumed the characteristic appearance of a *blastopunctum*. This animal is still under observation and the spot has grown smaller and lighter in color. After sufficient time has elapsed to allow for further spontaneous activity and complete regression this transplant will be stimulated by commercial hormones.

These experiments proved that at least some of the ovarian transplants were capable of spontaneous activity. Believing that these



Fig 1

Fig 1 An eye showing implants in their usual positions, *a*, ovarian tissue, *b*, endometrial tissue. These implants are about the average size and color before stimulation



Fig 2

Fig 2 This implant filled the anterior chamber of the eye from the ciliary body, *a* and the iris, *b*, to Decemet's membrane of the cornea, *c*. It was about one-fifth this size before stimulation. Ovarian changes ranging from a ripen-

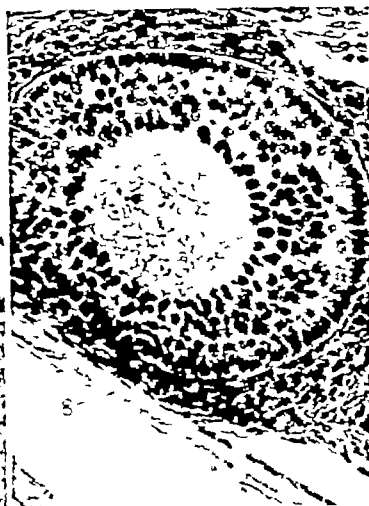


Fig 3

ing egg, *d*, through cystic follicular degeneration, *e*, to marked luteinization, *f*, are well illustrated. These changes are the result of stimulation by the intravenous injection of pregnant urine.

Fig 3 A high power section of the ripening egg, *d*, mentioned in Figure 3 lying against Decemet's membrane at *g*. The nuclear structure and corona radiata are well shown

grafts were the controlling factor in the blush and blanch mechanism, we again decided to test the response of the ovarian transplants in castrated animals with hormonal concentrates and pregnant urine. The results were startling. Within 30 to 48 hours following the injection of follutein, antuitrin S or pregnant urine, gross evidence of violent ovarian changes could be seen (Figs 2 and 4). The ovarian transplants increased five to ten times in size and their margins became studded with many large follicles. The pale color of the ovary changed to a dark cherry red and gross evidence of minute hemorrhages could be seen through the cornea. After 3 to 5 days the implants assumed a yellow-red or salmon colored tint which we interpreted, in the light of the microscopic sections of the eyes (Fig 5), as degenerating corpora lutea.

The endometrial tissue in the eyes just described remained in a constant state of blush in some instances, in a constant state of blanch in others. Whether this was due to the increased ovarian activity or was the direct effect of the injected hormone as Markee has reported, using menformon, we cannot say.

In one animal the endometrial transplant began to increase in size synchronously with the ovarian changes and grew progressively larger until the two implants almost filled the anterior chamber of the eye. At this stage the intra-ocular pressure became so great that we feared corneal rupture with extrusion and loss of the implants. The color of this hypertrophic growth had changed from its hyperæmic appearance to a pale yellow as if undergoing degeneration. The eye was enucleated and is now in the process of preparation. We will make no attempt to explain this phenomenon until the microscopic sections are studied.

All eyes removed were placed in Mueller's or Zenker's solution and imbedded in cello-don. Six to 12 weeks were necessary for satisfactory preparation. The eyes were serially sectioned and all sections preserved. Every fifth section was stained, mounted and numbered so that we could recover any desired areas in the future.

5 *Attempts at fertilization of ova which had been produced by artificial stimulation.* We have injected sperms into the anterior chamber of the eye with a fine hypodermic needle



Fig. 4

Fig. 4. This corpus luteum is the result of follicular stimulation by a commercial hormone (folutein).



Fig. 5

Fig. 5. The structure of the wall of the corpus luteum in Figure 4 is well shown in this higher magnification. The implant was removed in the early stage of regression. It had assumed the salmon color mentioned in the text. We interpret the color change as due to the fibrin layer.



Fig. 6

Fig. 6. Ovarian tissue, *a*, had been transplanted into the angle of the eye; endometrial tissue in the opposite angle (not shown) across the anterior chamber. The epithelium of the endometrium proliferated across the pupil and area here, *b*, lying on the anterior surface of the iris, *c*. In area, *d*, it has invaded the iris and is completely surrounded by fibrin tissue.

in 3 animals at periods varying from 10 to 48 hours after artificial stimulation and coincidental with macroscopic evidence of ovulation in the ovarian transplants. Ovulation was produced in 4 unoperated upon animals by the injection of folutein. Twelve to 48 hours later sperms were injected through the abdominal wall or poured directly over the ovaries at laparotomy. Implantation did not occur in any case. We shall continue this phase of the experiment along with attempts to fertilize ova produced by coitus with vasectomized bucks, since ova produced by artificial stimulation may not be normal.

6. *The possibility of the use of ovarian transplants in the eye as a test for pregnancy.* We are trying now to simplify the technique of the preparation of these animals so that castration and implantation of tissue into the eye may be done at the same operation. If this proves feasible a series of animals can be prepared easily and then be available for one to read when time or facilities for the usual procedures are factors. The repeated use of animals without operating upon them is worth considera-

tion. The only risk will be from the injection of toxic urine.

We have used 8 animals in these tests without a failure. In 1 rabbit the reaction while strongly positive in one eye was at least grossly negative in the other (Plate I frontispiece). This is difficult to explain and yet we have observed a comparable "defect" in reaction in one ovary in the usual Friedman test. This pregnancy test as modified by one of us (4) to increase accuracy afforded a splendid opportunity for checking the variations in response of both abdominal ovaries. Quite frequently the primary inspection of the ovaries revealed follicles that might be interpreted as a positive test if the ovaries had not been inspected previously. In at least 6 instances 1 ovary remained practically unchanged after repeated injections of suspect urine while the opposite ovary was the site of marked change as shown by many large recently ruptured follicles.

CONCLUSIONS

The ease of transplantation constant visibility a fluid filled space for growth and



Fig 7



Fig 8

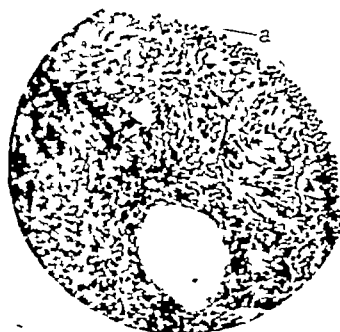


Fig 9



Fig 10



Fig 11



Fig 12

Fig 7 Metaplasia from the usual type of endometrial epithelium to that suggesting ciliated, *a*, high columnar epithelium of tubal type, *b*, has occurred in this section. Epithelium is not present on the anterior surface of the iris, *c*, in the normal eye.

Fig 8 Photomicrograph showing normal germinal epithelium, *a*, on the surface of an ovarian transplant. Proliferation of the germinal epithelium has occurred on the anterior surface of the iris, *b*, between *c* and *d*. It is interesting that the only primordial follicles, *e*, found by serial section lay just beneath and parallel to the surface of the germinal epithelium.

Fig 9 All of the ovarian transplants were cut from the abdominal ovary in the shape of isosceles triangles so that only the base could have been covered by germinal epithelium. This transplant had assumed a circular form. It was completely surrounded by germinal epithelium which

had proliferated to form four or five distinct layers, *a*. It is interesting that no primordial follicles were found by serial section of the implant.

Fig 10 The arrangement of cells in this section may be only an artefact but it suggests follicles in the process of formation. *a* represents a normal primordial follicle, at *b* and *c* the stromal cells seem to be arranging themselves into structures not unlike the theca of an early primordial follicle.

Fig 11 Cross section of a small implant in its entirety. The ovarian tissue lies within the iris completely surrounded by it. This was the only ovum found in the section and represents follicular structure beautifully.

Fig 12 High power magnification of the ovum illustrated in Figure 11 lying in the discus proligerus, *a*. The area *b* suggests formation of a polar body but may be due to a defect in preparation.

nourishment and prompt vascularization lead us to believe that the anterior chamber of the eye is an ideal location for the study of growth and physiological response of transplanted tissues.

We have further substantiated the fact that endometrial tissue has peculiar properties of proliferation of its epithelium with invasion of adjacent structures forming typical gland-like spaces (Fig 6), that frequently this epithelium

(Fig 7) undergoes a metaplasia to a type resembling tubal epithelium. One of us (1) reported a probable metaplasia of uterine epithelium to epithelium of tubal type in a previous article. Schochet has also observed this phenomenon. Sampson more recently suggested that tubal epithelium may undergo a transition and proliferation of its cells so as to be indistinguishable from normal endometrium. We are transplanting tubal epithelium into the eye to see

whether metamorphosis occurs into tissue of endometrial type.

Isolated segments of transplanted endometrium retain the property of alternate congestion and blanching which seem to be, at least, under the immediate control of ovarian activity.

We are impressed with the evident ease with which such a highly specialized tissue as that of ovary can be made to live in this location that over relatively long periods of time transplants will remain quiescent or resistant to their usual stimuli as long as other ovarian tissue is present in its normal location.

In some instances, at least the germinal epithelium suggests a power of proliferation (Figs. 8 and 9). In others it suggests ability to initiate new follicular formation as suggested by Swery and Evans (Fig. 10). This may be due to a compensatory hypertrophy following castration as indicated by the spontaneous appearance of follicles in transplants previously inactive. More definite evidence of this possibility is suggested by the regular appearance in implants of a sudden sensitivity

to ordinary ovarian stimuli following castration.

One is forced to conclude that all ovarian tissue is not simultaneously responsive to known potent stimuli. This may be due to the fact that a portion is in a resistant phase or because new ovules are in the process of formation and growth. These physiological functions are under control of blood borne stimuli and are independent of location and nerve supply. We are unable to explain some of these phenomena but future observations may lead to their solution. A radical change in our present conception of the formation of primordial follicles may be the result.

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THE VIABILITY OF STRANGULATED INTESTINAL LOOPS

AN EXPERIMENTAL STUDY¹

LAWRENCE JACQUES, M.D., W A DROEGEMUELLER, M.D., AND J R BUCHBINDER, M.D., CHICAGO

DURING recent years much progress has been made in the prompt recognition and relief of intestinal obstruction. Nevertheless, cases of severe strangulation are still encountered, and the problem of their proper surgical treatment is often a matter of doubt. A difficult phase of that problem is the accurate estimation of the degree of damage sustained by the strangulated bowel. The practice of exteriorizing doubtful loops has perhaps diminished the need for an accurate decision on this point. Nevertheless, exteriorization is not always feasible—particularly when very large segments of bowel have been involved, nor is it in itself an indifferent procedure. The morbidity and mortality resulting from the exteriorization of damaged loops which might safely have been returned to the abdomen are sufficiently great to justify a search for means to avoid this step when possible.

The work here reported was undertaken in an attempt to establish criteria of viability more accurate and reliable than those now available and to re-value those criteria now commonly in use.

METHOD

All experiments were performed on dogs. With the exception of a few instances where very brief strangulations were produced by means of clamps, the following method was adopted.

For purposes of uniformity, the terminal ileum about 6 inches from the ileocecal junction was chosen in all cases. The obstruction was produced at a low level to make possible an adequate survival period. A loop of ileum, measuring in its outer circumference about 5 times its diameter was chosen. A soft rubber cuff was sutured loosely about the base of the loop and a silk ligature was then tied over the cuff with the first loop of a surgical knot. This knot was slowly tightened until arterial pulsations in the strangulated mesentery were barely perceptible. The knot was then com-

pleted. To prevent further slipping in of contiguous segments of gut, a complication which at first occurred rather frequently, in all later experiments the cuff was loosely sutured to the mesentery above and below the point of strangulation. Observations were usually made in from 18 to 24 hours after strangulation. Despite all efforts to produce a uniform lesion, marked differences in the amount of ultimate damage were observed. These differences were attributed to such variables as the amount and character of the contents of the involved loop, the exact arrangement of the vascular supply in each case, and unavoidable variations in the actual degree of constriction produced. Following the period of strangulation, the abdomen was reopened, the condition of the strangulated loop investigated, the obstruction relieved, and the subsequent clinical course observed. The strangulated loops were examined from the following points of view: (1) gross pathological findings, (2) state of the vascular supply, (3) contractility, (4) permeability.

GROSS PATHOLOGICAL FINDINGS

Under clinical conditions the following procedure is usually employed in examining an exposed loop of strangulated bowel. The color of the bowel, its consistency, and the presence or absence of gross perforation, the quantity and character of the peritoneal fluid present, and the condition of the mesenteric vessels are quickly noted. The involved loop is then wrapped in hot, moist cloths, or when possible, returned to the abdomen, and after a varying period the damaged tissues are again examined for evidences of circulatory return. The criteria of such return usually employed are: (a) a change in color such as might result from an increased inflow of arterial blood, (b) the return of pulsations to the arteries of the involved mesentery.

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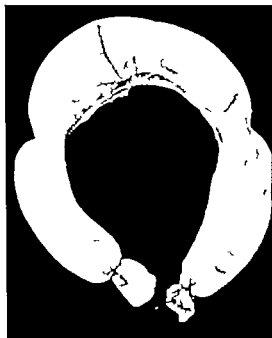


Fig. A viable strangulated loop in which death occurred from low grade obstruction resulting from annular scars at the points of constriction.

Of these 21 cases, 10 were regarded as clinically viable, 8 as non-viable, and in 3 cases viability as judged by gross clinical findings, was regarded as questionable. A brief analysis of these findings follows:

A. Color return. In all cases in this group the strangulated loop was released, dropped back into the abdomen, and observed 5 or 10 minutes later for evidences of improvement in color. In no instance in the 8 loops regarded as non-viable was any return observed. In the 13 cases remaining the subsequent clinical course demonstrated that the strangulated loops had retained their viability. In 10 of these there was a definite color return. In the 3 remaining, however, release of the strangulation was followed by no clearly recognizable improvement in color. On the basis of these and other associated gross pathological findings, these 3 loops were regarded as questionable. Clinically we should have hesitated to return them to the abdomen yet their viability was demonstrated by the subsequent course of events.



Fig. A mesenteric artery after 24 hours of strangulation. Note the marked edema, hemorrhage, and constriction about the artery. Although the lumen was entirely patent, no pulsations could be palpated. The mesentery in the lower left hand corner approaches the normal.

These results may be tabulated as shown in Table I.

TABLE I

Clinical diagnosis	No. of experiments	Diagnosis correct	Percentage
Non viable	8		00
Viable		8	00
Questionable	3		
Totals		8	85.7

B. Arterial pulsations. Clinically considerable weight is usually attached to the presence or absence of palpable pulsations in the mesenteric arteries of strangulated loops. Kocher emphasized the importance of this sign and Elsberg has stated that if strangulated gut is to be considered viable, the vessels must be pulsating throughout the entire segment" and that special attention should be paid to the vessels in the central portion of the segment. Observations on this point were made in the 21 experiments mentioned and in 10 additional experiments run primarily for

studies on surface temperature The results are shown in Table II

TABLE II

Clinical diagnosis	No of experiments	Diagnosis correct	Percentage
Non viable	12	12	100
Viable	16	1	6.2
Questionable	3	0	0
Totals	31	13	41.9

In only one of the 16 viable loops studied could pulsations be made out. Thus, under the specific conditions of these experiments, the presence or absence of mesenteric pulsations was a most unreliable index of viability

It was felt that this discrepancy must be explained in one of two ways (1) that the pulseless vessels were obliterated and the viability of the strangulated segments was maintained by collaterals, or, (2) that the absence of pulsations was not in itself proof of the occlusion of such vessels

An answer to the first question may be derived from studies on the blood supply of the small intestine, such as those of Rydiger, Eisberg and, most recently, Demel With minor variations, these authors are agreed that the arteries of the mesentery may be occluded with the greatest degree of safety in the second arcade (vessels of the second order—Demel), and that from this point on the danger rapidly increases as the mesenteric border of the intestine is approached Thus it is generally held that gangrene will result from the ligation of radial vessels to a segment of intestine approximately 5 centimeters in length. In these experiments, viability was frequently retained in segments considerably exceeding that length in the absence of pulsations anywhere in the strangulated mesentery The studies mentioned render it quite unlikely that such segments were being nourished by collaterals Furthermore, in surface temperature studies, which will be described in detail later, evidences of an inflow of blood into the mesenteric vessels after the release of strangulation were repeatedly observed with no return of pulsations Finally, in several instances, the patency of such vessels was established by direct examination (Fig 2) Thus, in the dog, under the conditions of these experiments, the absence of pulsations was not proof of the com-

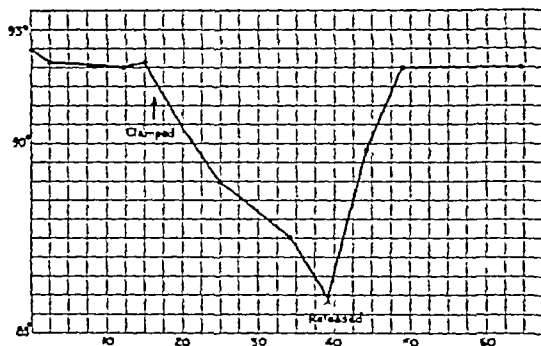


Fig 3 Normal bowel Clamping of the mesenteric vessels for a brief period resulted in a sharp drop in surface temperature followed by a prompt return to normal on release

plete obliteration of the vessels in the strangulated mesentery Apparently, in many cases pulsations were merely obscured by the marked oedema, hæmorrhage, and infiltration, invariably present along the course of these vessels after strangulation It is interesting, in this connection, that one of us (J R. Buchbinder) has repeatedly returned to the abdomen strangulated intestine in which there were no mesenteric pulsations, the diagnosis of viability being made on the return of color following release

C Miscellaneous observations 1 The odor of the peritoneal contents was recorded in each of the 21 cases in the group of experiments mentioned A gangrenous or faecal odor was regarded as evidence of necrosis The record is shown in Table III

TABLE III

Clinical diagnosis	No of experiments	Diagnosis correct	Percentage
Non-viable	8	6	
Viable	10	8	
Questionable	3	3	
Totals	21	17	80.9

It may be noted that while no viable loop was associated with a faecal or gangrenous odor, 4 of 10 non-viable loops were equally inoffensive in this respect The absence of faecal odor, therefore, was by no means reliable evidence of viability in these experiments

2 During the progress of these experiments increasing attention was paid to the consistency of the strangulated segments With accumulating experience, this point proved to

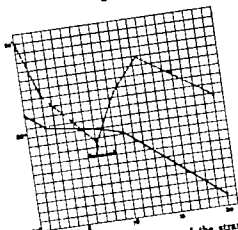


Fig. 4. The surface temperature of the strangulated bowel (solid line) dropped steadily in spite of the release of the constriction. A sharp rise in temperature occurred over the afferent vessels (dashed line) following release, although there were no pulsations. The loop was viable.

the gangrenous as with the viable loops. The amount of fibrin deposited upon the involved loop and about the material used for producing strangulation appeared to bear no relationship whatever to the severity of the lesion, some viable loops were thickly covered with fibrin, while some of the necrotic segments were enclosed in very thin films of fibrin or were almost free of such deposits. Thus it was felt that no accurate or material information regarding viability was afforded by the amount or gross character of the peritoneal exudate.

4. As to color viable loops were usually a deep red or purplish red while non viable segments were a deep red, black, or grayish black. Since in all cases the strangulation produced was such as to allow some ingress of arterial blood the strangulated loops were practically always haemorrhagic. In many of the non-viable loops the intestinal wall was stiff and turgid with coagulated blood. The amount of such interstitial haemorrhage appeared largely to determine the color of arterial constriction. In some instances a degree of arterial constriction sufficient to result in anemic necrosis of the bowel wall was inadvertently produced. Such infarcts appeared as grayish or yellowish pink areas, not always clearly demarcated and lacking the characteristic friability of hemorrhagically infarcted bowel. Areas of this type frequently bore a striking resemblance to normal bowel and on several occasions specific tests were necessary to determine whether such foci had merely escaped devitalization or had been entirely cut off from their arterial supply. While no attempt was made to draw conclusions from the color alone, this point was taken into consideration in arriving at the gross clinical diagnosis of viability in each case.

SPECIAL TESTS

A *Pricking test* In 1927 Davis reported a case of strangulated femoral hernia, in which, although the color of the diseased gut did not return to normal, it was possible to demonstrate free bleeding upon pricking the wall of the bowel with a needle. Upon the basis of this finding, the loop was returned to the abdomen and it proved to be viable. It is interesting that this rather primitive procedure should be one of the very few specific tests for

be a most significant index of the state of the damaged bowel. It is possible that changes in consistency may more easily be distinguished in the thick muscular intestine of the dog than in human gut. Nevertheless, it is of interest that the diagnosis, based on consistency alone, was correct in all of the 30 cases in which findings were recorded on this point. Irreparable damage was held to be present when the bowel wall was anywhere flabby, inelastic, thin, and peculiarly flabby. Loops with plump pliable elastic walls survived in every case, irrespective of other findings. Unfortunately a rather marked peritoneal equation is involved in arriving at conclusions based on this characteristic. The authors feel definitely that their own accuracy was due to the opportunities for a concentrated experience yielded by this series of experiments.

3. In 18 of the 31 cases in the series mentioned, a serohemorrhagic peritoneal exudate was present. Perforations of the strangulated loops were twice encountered. In one of these the peritoneal fluid was distinctly purulent, while in the second the exudate was described as serohemorrhagic. In no other instance was a frankly purulent exudate observed. In general, the amount of exudate varied with the degree of damage, approximately twice as much fluid being present on the average with

viability referred to in the literature. In the present work it was found that stagnant extravasated blood would frequently ooze from puncture wounds made in definitely gangrenous bowel. We, therefore, decided to make observations on each loop before and after release of the strangulation, the character, as well as the presence or absence of oozing, being reported in each case. The test was performed in this way in 20 experiments. We regarded it as positive only if bleeding was more active and if the color of the escaping blood became lighter after than it had been before release. The results are shown in Table IV.

TABLE IV

	No of experiments	Correct	Percentage
Gangrenous	10	10	
Viable	7	7	
Questionable	3	1	
Total	20	18	90

It is significant that the only two instances in which the test was misleading occurred in questionable loops. Furthermore, an obvious objection is the necessity for making puncture wounds in bowel already damaged by strangulation. It was felt that in many cases the danger from this source was great enough to contra-indicate the procedure.

B. Reaction to drugs affecting the circulation

Drugs specifically affecting the minute vessels of the skin, in particular, histamine, have proved useful in demonstrating the state of the vascular supply of the extremities. An attempt was here made to apply similar methods to the study of the circulation of strangulated loops.

1. Histamine acid phosphate in a solution of 1:1000 produced no visible color reactions when applied to the serosa of normal or strangulated intestine. The color of such loops, particularly after strangulation, precluded the possibility of visualizing an arterial flare, such as can readily be produced in the skin. Frequently the application of histamine to the surface, or especially its injection into the muscular wall, was followed by strong rhythmic or tonic muscular contractions. It was found that similar, although less marked contractions, could be produced by simple

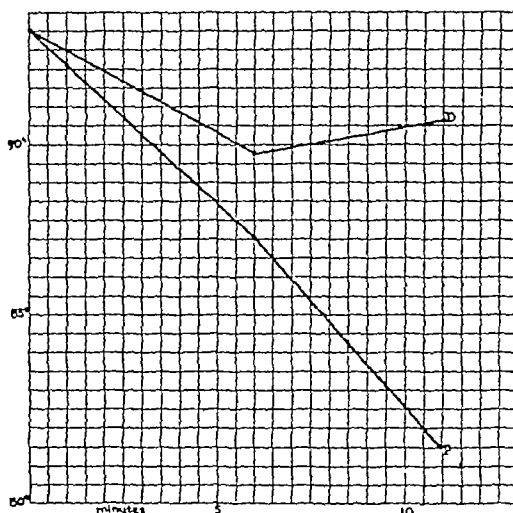


Fig. 5. An 18 hour strangulation. The temperature of the distal collapsed loop, *D*, was maintained while that of the proximal distended loop, *P*, dropped steadily.

manipulation or by the introduction of a needle alone without injection.

2. Pituitrin and adrenalin. Because of the disturbance in motility, resulting from injection, we confined ourselves to the application of these substances to the serosa. It was found that when a drop of surgical or obstetrical pituitrin was placed on the serosa of normal gut, an area of blanching, corresponding sharply to the limits of the drop, could be produced. This reaction usually appeared within 30 seconds after application of the drop. When, after its appearance, the drop of pituitrin was sponged away so that the serosa could be directly observed, the blanching was found slowly to fade, disappearing completely after several minutes. Similar, although less marked responses, were obtained by the application of 1:1000 adrenalin chloride. Lewis regards the blanching produced by the intracutaneous injection of pituitrin or adrenalin as the result of the direct stimulation of the walls of all of the minute vessels of the skin—arterioles, capillaries, and venules. It was felt that the blanching produced here occurred on a similar basis and that it, therefore, demonstrated the presence of living minute vessels with contractile walls and liquid contents. The value of this reaction as an index of viability was therefore investigated. Observations were



Fig. 6. Arteries of the small intestine in the dog. 1, Radial vessels; 2, circular artery; 3, vessels of the third order; 4, vessels of the second order; 5, vessels of the first order.

made in 7 preliminary experiments and 18 of the group of 21 experiments already mentioned. While at first promising results were obtained, serious difficulties were soon encountered. Normal intestine did not always give clear cut reactions, variations apparently depending on differences in vascular and muscle tone. After strangulation, the test was often precluded by the presence of fibrin. Finally in some instances water alone, when applied to the serosa, produced areas of blanching which were attributed to local inhibition. While these never approached the intensity of the reaction to pituitrin in viable intestine, it became necessary to control all positive reactions with water so that the test was considerably complicated and prolonged. In the 35 experiments in which the reaction to pituitrin was observed, the results shown in Table V were obtained.

TABLE V

	No. of ex- periments	Correct	Incorrect	Percentage
Viable	1	1		
Gangrenous	1	1		
Questionable			6	Correct—76
Total	3	10		

C. Temperature reactions. At the suggestion of Loyal Davis, a study was made of surface temperature changes in strangulated loops. No previous observations on this point have

been found. Determinations were made with a thermocouple. The surface temperature of normal loops delivered from the abdomen and exposed to the air at room temperature was found to remain almost stationary or drop slowly in a straight line during periods of observation as long as 30 minutes. When such a loop was clamped tightly enough to shut off its arterial supply for a twenty minute period, there was a sharp drop in temperature, followed by a prompt return to normal upon release of the constriction. Following preliminary studies, observations were made on a series of 10 strangulations prepared for this purpose. The strangulated loop was brought out and an initial temperature taken as soon as possible after delivery. A point at the center of the loop was usually chosen for observation. The segment was allowed to cool for a brief period, during which readings were taken at short intervals. The strangulation was then released and the temperatures again recorded. In this series, 8 obviously viable and 2 gangrenous loops were produced. No recovery as indicated by temperature changes could be demonstrated in either necrotic group or in 6 of the 8 viable loops. In one experiment, while there was no actual rise in temperature after the release, there was no further fall. If this is to be accepted as evidence of recovery the test may be regarded as correct in 5 of the 10 cases in the series, or 50 per cent. In one of the experiments in which the loop was gangrenous, several inches of apparently viable bowel had slipped through the rubber cuff to join the strangulated segment. In this portion there was a prompt and definite rise in surface temperature, upon release of the constriction.

Early in these experiments, it was noticed that in normal intestine there was a definite downward gradient in surface temperature from the mesenteric vessels themselves to the antimesenteric border of the gut, to the antimesenteric border. In several experiments of this series, readings were made directly over the larger vessels of the strangulated mesentery with somewhat more encouraging results. Observations on this point were made on 1 viable and 1 necrotic loop. In the on-

necrotic loop the temperature directly over

the mesenteric vessels continued to fall rapidly after release. In one of the viable loops, there was a slow drop in temperature also after release, while over the mesenteric vessels of the 4 remaining viable segments a definite rise was observed. Thus, the test was correct in 5 of 6 cases, or 83.3 per cent.

It is evident, therefore, that an increased inflow of arterial blood did not always produce a measurable increase in the surface temperature of the intestine. Apparently the amount of blood reaching the oedematous, hæmorrhagic intestine was not sufficient to supply more heat than that being lost by radiation. Cooling may have been hastened by the moisture produced by the thin serous fluid which frequently exuded from the serosa upon release of the constriction. Such exudation was often observed after release in viable loops and was regarded as corroborative evidence of viability.

An incidental finding of interest may here be recorded. It was found that in most cases, the bowel above and below the strangulation cooled more rapidly than healthy bowel in normal dogs. Usually, the proximal gut was distended and the distal segment was collapsed. In several instances we observed that the proximal distended segment cooled much faster than the distal collapsed bowel. These differences were attributed to the effect of distention upon the circulation of such bowel. In 1877, Kocher observed that the pressure in the distended bowel might easily exceed that of the intestinal vessels and thus produce necrosis and perforation above a mechanical obstruction ("Ausdehnung" ulcers). These observations were confirmed clinically by Van Buren and experimentally by Van Zwaluwenburg, Gatsch, and Dragstedt, Lang and Millet. It is felt that they have been corroborated by our own experiments.

D Contractility As a rule no attention is paid to the contractility of strangulated loops, except for perfunctory attempts to produce contractions by pinching. Nevertheless, there is evidence that the fate of strangulated gut is largely dependent upon the state of its muscular layers. Thus, Buchbinder (1900) concluded that the loss of muscular response to adequate electrical stimulation could be ac-

cepted as positive evidence of irreparable damage to the bowel wall. As far as we have been able to discover, no attempts have been made to confirm this author's careful and exhaustive studies. Two factors may alter the contractility of strangulated loops. In the first place, strangulation is associated with marked degrees of distention with consequent thinning and stretching of the muscular layers, which may itself produce a temporary loss of contractility. With the relief of tension, contractility returns after periods varying with the duration of the obstruction. In Buchbinder's experiments, contractility was regained in viable loops from 2 to 40 minutes after the release of obstruction. In the second place, a group of changes occur which are directly attributable to the state of the intestinal circulation. In almost all clinical strangulations as well as those produced here, there is at first chiefly an obstruction to the venous outflow, with relatively little diminution in the inflow of arterial blood. With continued strangulation, there is further distention of the intestinal wall, with rapidly increasing interstitial hæmorrhage and oedema. As a result, there occurs a progressive occlusion of the intramural vessels, involving first the veins and finally the arteries. In severe and prolonged strangulations, this process may be accompanied by a thrombosis of the mesenteric vessels. When, as a result of this combination of circumstances, the arterial supply has been sufficiently compromised, necrosis occurs, beginning in the mucosa and extending in time to the already disorganized and disintegrating muscular layers. When such changes have taken place, the return of contractility from the relief of tension alone is no longer possible.

Mechanical, chemical, and electrical stimuli may be used to elicit intestinal contractions. Mechanical measures are dangerous and unreliable. Chemical stimulation was employed by Nothnagel (1882), who produced intestinal contractions by applying crystals of sodium and potassium salts to the intestinal serosa. Luecke used this method to determine intestinal orientation by observing the direction of the peristalsis produced in this way. Others (Hahn) failed to obtain uniform results with this procedure. In the present work we re-

sorted to electrical stimulation. A fairly strong current sufficient to cause a sharp and prompt contraction of skeletal muscle was used. When such stimulation is applied to the surface of a loop of gut for periods varying from a few seconds in normal to about 2 minutes in strangulated loops, a localized stationary ring like spasm develops at the point of stimulation. When the current is withdrawn the spasm so produced may persist for from a few seconds to 1 or 2 minutes. Faradic stimulation was employed in 19 of the group of 21 experiments described. Observations were always made after all other tests had been carried out, that is, from 10 to 20 minutes or more after release of constriction to allow as much recovery from distention as possible (Table VI).

TABLE VI

	No. of experiments	Correct	Incorrect	Percentage
Gangrenous	8	8		
Viable	8	7		
Questionable	3	1	3	33.3
Total	19	16		

In strangulated but viable bowel, the contractions produced were often manifested as shallow furrows not involving the entire circumference of the bowel. With moderate practice, it was easy to distinguish such contractions from artificial depressions made by the pressure of the electrode.

The test was regarded as incorrect in 2 of the 3 questionable loops. In both of these, contractions were elicited at some points while others remained entirely refractive. Had the retention of contractility in a large part of these loops been accepted as evidence of viability for the entire segment, the test would have been correct in all cases but one.

Mechanical stimulation (pinching) was tried in a few experiments, but was soon abandoned. It was observed that such efforts frequently traumatized the strangulated bowel and produced no contractions when the response to electrical stimulation was prompt and definite.

E. Permeability to bacteria. It has been shown that under various circumstances the grossly intact intestine may become permeable to bacteria, allowing invasion of the mesenteric lymphatics and blood vessels (Hornemann Arnold) or of the peritoneal cavity. The litera-

ture on the latter type of invasion with which we are here concerned permits of no definite conclusions. Experimentally it has been demonstrated that virulent bacteria may pass through intestinal walls unprepared by previous injury (Bail, Geiswald—streptococcus Jensen—pneumococcus). Clinically there is a group of conditions variously referred to as haematogenous, klopheptic "durchwanderung," and migratory peritonitis, in which there is good evidence that the peritoneum is invaded through an intestinal wall which is intact except for varying degrees of enteritis (Lennander and Nyström. Rohr Erkes, and Karlman). This subject has recently been reviewed by Wile and Saphir. In the present work we have been interested in the permeability to bacteria resulting from strangulation. From the beginning evidence on this point, from both clinical and experimental sources, has been conflicting. Clinically slight degrees of strangulation with positive bacteriological findings, were observed by some, while others reported severe strangulations with no evidences of penetration by bacteria. In 1900, Buchbinder undertook to settle the question experimentally. From a large and careful series of observations, in which easily recognizable organisms (*Bacillus prodigiosus*) were used as an index of permeability, it was concluded that bacteria penetrate the entire thickness of a gut only in the presence of severe and irreparable damage. In support of this view it was pointed out that the passage of bacteria into the peritoneal cavity was invariably accompanied by a loss of contractility to faradic stimulation. Helmsberger and Martens, repeating Buchbinder's work with somewhat modified methods, essentially confirmed his conclusions, namely that the degree of injury necessary to permit the passage of bacteria was severe and irreparable. Histological studies demonstrated that the mucosa and submucosa offered little resistance to the progress of organisms, that the muscularis presented by far the most effective barrier to their invasion and that, finally bacteria could be demonstrated in that layer only in the presence of definite necrosis of its elements. On the other hand Bornscky and Genesich were able to culture *Bacillus coli* in a large

percentage of cases from the surfaces of distended intestine proximal to simple ligature obstructions, in which the distention and a few punctiform hæmorrhages constituted the only evidences of damage. More recently, Mandl claims to have demonstrated the passage of intestinal flora through loops of sigmoid brought out of the abdomen preliminary to colostomy. His conclusions seem highly questionable.

In the present study, we attempted to determine whether bacteriological findings might be of practical assistance in the diagnosis of viability. For this purpose, direct bacterial smears were taken from the peritoneal surfaces and fluid. Because of our interest in the theoretical aspects of the problem, cultures were also made in most cases. The following technique was employed.

During the preliminary operation most careful asepsis was observed. When the abdomen was reopened, precautions were taken to avoid contamination from the wound until smears and cultures had been made. All instruments used in reopening the wound itself were immediately discarded. The edges of the peritoneum were then brought out and clamped to sterile towels, completely excluding the extra-peritoneal portion of the wound. Smears and cultures were then made whenever possible without delivery of the strangulated loop, that is, before any instrument or the operator's hands had invaded the peritoneal cavity. Culture material was inoculated into tubes of dextrose broth. The results are shown in Table VII.

TABLE VII

Smears				
	Experiments	Correct	Incorrect	Percentage
Gangrenous	9	7	2	
Viable	8	8	0	
Questionable	3	3	0	
Total	20	18	2	90
Cultures				
	Experiments	Positive	Negative	
Gangrenous	7	7	0	
Viable	7	4	3	
Questionable	2	2	0	
Total	16	13	3	

The 2 errors occurred in gangrenous loops in which the search for bacteria was unsuccessful. The procedure was less satisfactory as a practical test, however, than these results would indicate. In some experiments in which necrosis was definite, bacteria could be found only after prolonged and careful search. A long painstaking microscopic examination of smears would hardly be suitable as a practical clinical test for viability. It may be noted from the second part of the table that positive cultures were obtained from 6 of the 9 viable smear-negative loops. Only 2 of these were suspected of being contaminations. Nevertheless, under the conditions of these experiments, the possibility of infection introduced at the preliminary operation could not be absolutely ruled out in any case. Since our interest in these cultures was incidental, no special methods for culturing organisms were used, and no definite conclusions will be drawn on this point.

RESULTS

The results obtained are summarized in Table VIII.

TABLE VIII—SUMMARY

Test	No of experiments	Correct	Percentage correct
Consistency	21	21	100
Bacterial permeability	20	18	90.0
Pricking test	20	18	90.0
Color return	21	18	85.7
Contractility	19	16	84.2
Temperature mesenteric arteries	6	5	83.3
Odor	21	17	80.9
Blanching reaction	25	19	76.0
Temperature intestine	10	5	50.0
Mesenteric pulsations	31	13	41.9

As we have repeatedly stated, the figures quoted did not always represent accurately the practical value of each test. Furthermore, our skill in making a gross diagnosis on consistency and color return, alone, increased rapidly with accumulating experience, so that our

An analysis of the table reveals a close correspondence between the presence of bacteria in smears and the degree of damage present

need for special methods decreased as the work progressed. It is for that reason that on the basis of gross characteristics, only 3 of the group of 21 loops mentioned were regarded as questionable. A comparison (Table IX) of the various criteria of viability in these 3 cases may throw some light on their relative value.

TABLE IX

	Color return	Contractility	Odor	Pain- tense	Prick- ing	Wash- ing	Con- tractile response	Bac- terial prolifer- ation
1	Dark- red	Elastic	Not fecal		Mixed			Mixed
2		Elastic	Not fecal				+	Mixed
3		Elastic	Not fecal		pink	pink	pink	

Thus, in these 3 experiments, while little or no color return occurred and pulsations were absent, the bowel wall in all cases had retained its elasticity. Pricking revealed evidence of an inflow of blood in 2 cases, contractility was retained partially in 2 and completely in 1 case, and bacterial smears were negative. These experiments indicate that the results obtained with faradic stimulation, the prick test, and bacterial smears, together with the consistency of the damaged gut, may furnish valuable evidence as to the viability of such doubtful loops. Temperature studies were not made in these experiments. Of all of the special methods of examination available, we feel that electrical stimulation is the simplest, safest, and most reliable. Buchbinder, whose experiments also conclusively proved its accuracy also demonstrated its value in 3 clinical cases of intestinal obstruction with strangulation.

It was our impression, when these studies were begun, that gut is at present frequently regarded as gangrenous when its return to the abdomen would have shown it to be viable. On the other hand, Eisberg has reported several cases in which strangulated intestine was returned to the abdomen after a definite color return had been observed, and necrosis, perforation and death, subsequently occurred. Such a sequence of events has not been en-

countered in these studies. On the other hand, it is not to be expected that seriously damaged, though viable intestine, which is returned to the abdomen will always be restored to its previous normal condition. Buchbinder stated that high grade injury of the gut wall, with deep lesions of the mucosa, partial necrosis, and extensive hemorrhage into the remaining layers, need not bring about death of the animal if firm adhesions develop which prevent perforation into the peritoneal cavity. He observed instances in which spontaneous anastomoses had occurred between adherent loops. In our own work, while no fistula were seen, autopsies on animals which survived frequently revealed dense adhesions about the strangulated segment. In several cases, the entire segment was distinctly narrower than the adjacent bowel, with ring-like scars at the points of constriction. In one instance these ring-like constrictions produced a low grade obstruction, which was apparently responsible for the death of the animal about 30 days after relief of the obstruction (Fig. 1).

SUMMARY

In a group of experiments on dogs, an attempt was made to establish more accurate criteria than those now available for the viability of strangulated intestinal loops. The results of a comparative study of various criteria are recorded. With increasing experience, a considerable degree of accuracy was attained on the basis of gross pathological character-istics alone. Of these, the consistency of the strangulated intestine and the return of color after release of the obstruction were of most value while the mesenteric pulsations, odor and the amount and character of the exudate present were misleading. It is of particular interest that the absence of pulsations over the mesenteric arteries could not be accepted as evidence of the occlusion of these vessels. Of the special tests performed the demonstration of contractility to faradic stimulation was regarded as the most significant, while bacterial smears, surface temperature observations over the mesenteric vessels, the bleeding resulting from pricking and the blanching reaction to pituitrin appeared to have some corroborative value.

The disturbance of intestinal circulation by distention, which has previously been demonstrated, was confirmed by surface temperature studies

Within the limits of the technique used, these experiments do not support the view that actual necrosis of strangulated bowel wall is necessary to permit the passage of bacteria

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A LIVER KIDNEY SYNDROME

CLINICAL, PATHOLOGICAL, AND EXPERIMENTAL STUDIES

FERDINAND C. HELWIG, M.D. AND CARL BRIANT SCHUTZ, M.D. KANSAS CITY, MISSOURI
From the Departments of Pathology and Surgery, St. Luke's Hospital, Kansas City, Missouri,
and the University of Kansas School of Medicine

THE observation that certain pathological changes in the liver bear a peculiar relationship to certain pathological changes in the kidneys has frequently been alluded to in the literature. Though there are rather definite characteristics of this relationship, no serious attempt has been made to explain its mechanism or to study it as an entity.

It is our purpose to describe such pathological changes as constituting a definite and not infrequent, clinical syndrome which manifests itself in cases of severe hepatic injury. At St. Luke's Hospital we have observed a characteristic train of clinical symptoms and pathological changes in 6 cases which we would classify in this syndrome. We have experimentally produced similar clinical and pathological manifestations of the syndrome in animals and are at present continuing this study in an attempt to explain its mechanism.

CASE REPORTS

The clinical and pathological picture of the syndrome is illustrated by the following résumé of the 6 cases which we have studied. We are indebted to Dr. H. P. Kuhn and Dr. T. G. Orr for the privilege of investigating these cases.

CASE 1: The patient was a well developed male, 49 years old. He gave a history of gall-bladder disease dating back more than 5 years. Five months before admission to the hospital, he had his first attack of gall-stone colic. Two weeks following this attack of gall-stone colic, he was removed. He was well, nine diseased teeth were removed when he was then free from pain for one month when he suffered a similar attack of colic. Since this last attack he suffered almost constant pain in the gall bladder region. He was never jaundiced. On admission to the hospital, his liver was found enlarged to two fingers breadth below the costal margin, its edges firm and smooth, and a tender hard gall bladder was palpable. Routine urine, blood, and blood chemistry examinations revealed no abnormality. At operation, a large, thick walled, infected and orduous gall bladder containing many stones,

was removed without difficulty. The cyst duct was dilated and contained one stone. The microscopic picture was that of a long standing chronic inflammation. The postoperative course was uneventful until the sixth day when a generalized edema developed. The oral temperature rose to 102 degrees, the pulse to 110. The leucocyte count rose to 16,000 and the urine for the first time contained a heavy trace of albumin and many hyaline casts. On the next day after the removal of the edema, the wound opened widely and drained a considerable amount of blood. It contained no clots and showed no evidence of healing. The urine contained albumin plus 4, many granular casts, and microscopic blood. The urinary output was decreased, the non-protein nitrogen of the blood rose to 55 milligrams per 100 cubic centimeters, and the creatinine increased to 4.5 milligrams per 100 cubic centimeters. The patient became semi-comatose, his abdomen became distended, and he began vomit. The following day (eighth postoperative day) he became comatose, edema increased, the urinary output practically ceased and consisted almost entirely of blood. Vomiting continued and soon became bloody. The stools were profuse and consisted largely of blood. The blood non-protein nitrogen rose to 155 milligrams per 100 cubic centimeters and the creatinine to 6 milligrams per 100 cubic centimeters. Upon the ninth postoperative day all symptoms became more marked. Blood drained from the bladder the operative wound, the penis, stomach, and intestinal tract. The blood non-protein nitrogen rose to 175 milligrams per 100 cubic centimeters and the creatinine to 8.6 milligrams per 100 cubic centimeters. The patient died on the following day in a clinical state of uremia. Upon the day of his death, for the first time a slight icteric tinge appeared.

Anatomical findings. The skin, the lips, and buccal mucosa contained many petechial hemorrhages. A small amount of bloody fluid was present in the peritoneal cavity. The liver weighed 1900 grams. The gall-bladder lumen contained granulation tissue and clots. The liver capsule was pale. On cross section, the liver surface was pale and shiny. The lobulations were indistinct, and innumerable fine grayish points were visible scattered over the entire cut surface. Fatty changes were not apparent.

Both kidneys were markedly swollen, the left weighing 25 grams and the right 20 grams. Both capsules were tense but stripped with ease. The cut surface of both kidneys was yellowish red and

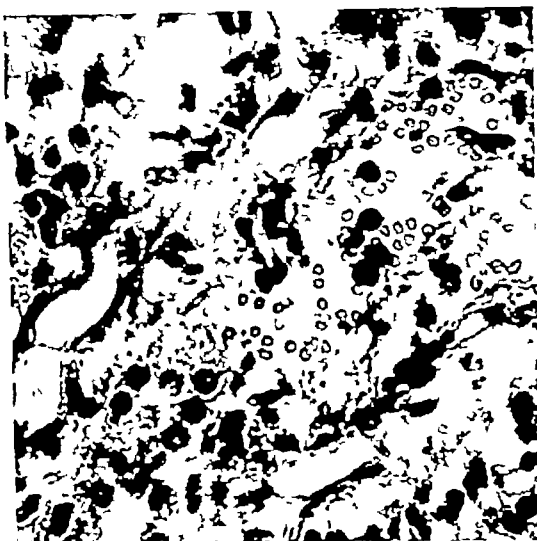


Fig 1 Case 1 Photomicrograph of kidney showing leucocytic infiltration, hæmorrhage, and tubular degeneration. $\times 500$

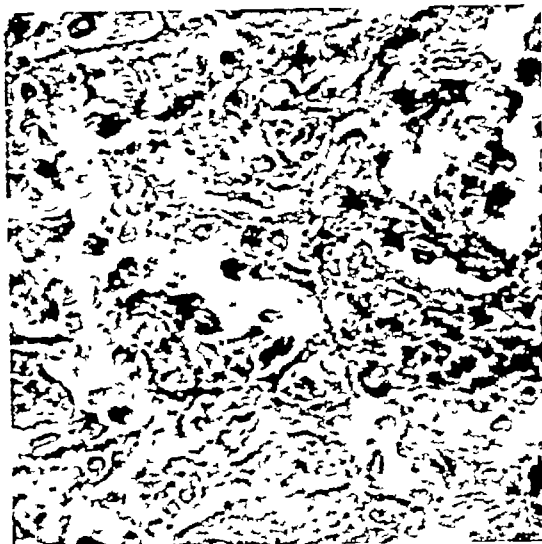


Fig 2 Case 2 Photomicrograph of liver in area of traumatic pulpification. Note dead anuclear liver cells $\times 900$

juicy, with swollen, poorly marked cortices. Definite submucous hæmorrhages were seen in the pelvis of each. The stomach, duodenum, and entire intestinal tract were filled with bloody liquid. Small submucous hæmorrhages were scattered throughout the mucosa of the small intestine. No ulcers were present. The bronchi and trachea were filled with bloody froth.

Microscopic pathology The liver contained patchy areas of fatty infiltration and exfoliated Kupffer cells. Large numbers of mononuclear leucocytes, eosinophiles and occasional polynuclear leucocytes were present. In both the sinusoids and portal spaces marked degeneration of the parenchymatous cells was observed throughout the liver. A more marked reaction was noted in an area rather closely surrounding the gall-bladder fossa than in the rest of the liver, here, also, peripheral fibrosis and monocyctic infiltration were marked.

The kidneys contained marked focal interstitial infiltrations of round cells. In the medulla, polynuclear and eosinophilic leucocytes, scattered areas of cloudy swelling, and rather heavy infiltrations of plasma cells and round cells were the most striking changes. In the cortex, many tubules were filled with red cells, and leucocytic infiltration was visible in the stroma and some of the tubules. In the convoluted tubules and in Henle's loops a very striking and advanced parenchymatous degeneration of the epithelial cells was observed. In places, this degeneration had advanced to actual necrobiosis.

Sections through the areas of hæmorrhage in the small intestine demonstrated patchy hæmorrhages in both the muscularis and submucosa.

CASE 2 The patient was a male, age 16, who was perfectly well until the day he entered the hospital. On this day he was in an automobile accident in which the car rested for several minutes on his chest and upper abdomen. On admission to the hospital, he was in deep shock. His abdomen was soft, his pulse normal, and he did not complain of pain. X-ray examination demonstrated fractures of the right clavicle and fifth, sixth, and seventh ribs. Subcutaneous emphysema was present over the right chest. A catheterized specimen of urine contained blood and albumin in small amounts. On the second day, the upper abdomen became tender and slightly rigid, and light icterus developed. His general condition remained about the same until the fifth day when an accumulation of fluid in the upper abdomen, together with an increasing pulse rate raised the suspicion of a ruptured viscus. At operation, bloody fluid was found in the abdominal cavity. After placing a small rubber drain in the gall-bladder region the wound was closed. The patient grew rapidly worse. Jaundice deepened and severe vomiting developed. The temperature assumed a remittent type (rising as high as 102) and the leucocytes increased to 14,000. A generalized cedema and a marked secondary anæmia rapidly developed. Blood drained from the operative wound, the bowel, the bladder, and was present in the vomitus.

Coarse granular casts and albumin to plus-4 appeared in the urine. The urinary output decreased to anuria. The blood non-protein nitrogen rose to 240 milligrams per 100 cubic centimeters and creatinine increased to 25 milligrams per 100 cubic



Fig. 3. Case 4. Photomicrograph of liver showing extensive interstitial hemorrhage and degenerative changes in portion not involved by carcinoma. $\times 50$.

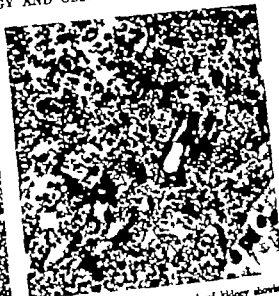


Fig. 4. Case 4. Photomicrograph of kidney showing calcification, necrosis, and leucocytic infiltration in areas of the medulla. $\times 500$.

centimeters. The nitrogenous products in the urine practically disappeared. The patient became deeply comatose and soon died in a clinical state of anemia.

Pathological findings. The abdominal wound was poorly healed. The peritoneal cavity contained a considerable amount of bright red bloody fluid. All viscera were jaundiced. The liver weighed 5,350 grams. On the upper surface of the right lobe, the liver capsule was slightly lacerated. Between the right and left lobes was an area of polypification which extended completely through the liver substance and almost separated the right lobe from the left. This band of polypification measured from 2 to 4.5 centimeters in diameter. The capsule over this polypified area was discolored but not torn. The area of trauma included the proximal branches of both right and left hepatic ducts but neither these nor the extrahepatic passages were occluded. The liver not included in this area of trauma, was jaundiced and the bile ducts somewhat dilated.

The kidneys were large and pale. Together they weighed 560 grams. Their capsules stripped easily and on section they presented pale, yellowish, and on occasion they presented dark, mottled, boggy surfaces. The markings of the medulla and cortex were indistinct and the bases of the pyramids hyperemic.

Subpleural interstitial hemorrhages varying in size from 5 to 15 millimeters were found in both lungs. The fractured ribs did not penetrate the pleura. Hemorrhages were found in the mucosa of the entire intestinal tract.

Microscopic pathology. In the non-traumatized liver tissue, some bile thrombi were present and both the parenchymal and Kupfer cells contained

bile pigment. Some of the latter cells were degenerated. The pulpy area contained large numbers of anuclear hyaline, necrotic, parenchymatous cells and massive hemorrhages. Occasional fibroblastic granulation tissue could be seen invading this traumatized area.

The parenchymatous cells of both kidneys were profoundly degenerated. The cortices were markedly swollen and many of the tubular epithelial cells had lost their nuclei. In scattered areas, tubular necrosis was severe, and many of the tubular lumina were filled with cast and albuminous debris. In the medulla, small interstitial hemorrhages and numerous groups of fibroblasts, round cells, eosinophils, and plasma cells were present. Special fat stains failed to demonstrate fat droplets. Only rarely were bile pigment granules observed in the kidney epithelium.

The duodenal mucosa was swollen. The surface epithelium had lost its nuclei and was deeply bile stained. Extensive submucous accumulations of red blood cells were found in both the large and small intestines in the areas where focal hemorrhages had been observed in the gross.

CASE 3. The patient was an obese male, age 63 years, who for a year prior to admission to the hospital had frequent attacks of upper abdominal pain and was treated as case of abdominal angina. He was never jaundiced. Ten days before this admission, he had sudden attack of apparent gallstone colic associated with nausea, vomiting, fever to 1.3 degrees, and slight jaundice. On admission to the hospital, he had a leukocytosis of 16,000, upper abdominal rigidity and a palpable mass in



Fig 5 Case 4. Photomicrograph of kidney showing profound degenerative changes in tubular epithelium. Note disappearance of nuclei in some of the cells. $\times 500$



Fig 6 Case 4. Photomicrograph of liver showing carcinomatous metastasis in angiomatous area. $\times 150$

the gall-bladder region. Under treatment, his symptoms rapidly subsided. His laboratory findings were normal. Cholecystostomy was performed 8 days after admission. The gall bladder was buried in dense adhesions. It was small, contracted, considerably reddened and thickened, but contained no stones. No obstruction was found in any of the bile ducts. The postoperative course was uneventful until the fourth day when, after a slight chill, the temperature rose to 103 degrees and blood began draining from the cholecystostomy tube. The abdomen became distended and slight nausea developed. Both pain and jaundice were absent. The leucocytosis increased to 45,000 but the patient's general condition remained about the same until the seventh postoperative day when the abdominal wound broke open. There was no evidence of healing. The abdomen became markedly distended and nasal tube gastric drainage contained a small amount of blood. As the patient grew rapidly worse, the leucocytes dropped to 16,000. He vomited large quantities of bright red blood and had profuse bloody stools. Blood drained from the operative wound, the mucous membranes of the mouth, and appeared in considerable amounts in the urine. Granular casts appeared in the urine and albumin increased to plus-4. An oliguria developed which progressed almost to anuria. The blood non-protein nitrogen rose to 58 milligrams per 100 cubic centimeters and the creatinine to 3 milligrams per 100 cubic centimeters. The patient passed from muttering delirium to coma and died in a clinical state of uraemia.

Pathological findings (Permission was obtained for exploration through the abdominal wound only.)

There was no evidence of healing in the operative wound. The subhepatic fossa contained a few post-operative adhesions and a few small unorganized clots. A small, old band of adhesions stretched across the common duct and partially obstructed its lumen. The liver was enlarged, soft and mottled and showed marked parenchymatous swelling. Both kidneys were quite large and pale. The capsules stripped easily. Section of the kidney revealed a marked generalized cloudy swelling. The bladder was empty.

The stomach and large and small intestines were filled with blood. No ulceration of the mucosa was visible grossly, though there were many submucosal areas of haemorrhage. Both the trachea and bronchi were filled with blood.

Microscopic pathology Cloudy swelling and fatty degeneration were present in all portions of the liver. The portal areas contained a considerable increase in both fibrous tissue and round cells. In scattered areas, the parenchymatous cells were undergoing granular degeneration. In both the portal spaces and the sinusoids there were considerable collections of mononuclear and polynuclear leucocytes and eosinophiles. The kidney sections revealed a striking parenchymatous degeneration of the tubular epithelium. Many of the convoluted tubules were dilated and their epithelial cells ragged and anuclear. Actual epithelial necrosis was common. The lumina of most tubules were filled with granular precipitates. In the medullary region many focal areas of interstitial mononuclear leucocytic infiltration were present. Granular degeneration, exfoliation, and nuclear caryolysis of the epithelial cells were common.

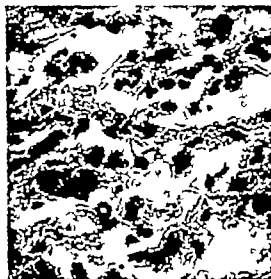


Fig. 7. Case 5. Photomicrograph of liver showing extensive necrotic infiltration and parenchymatous cell degeneration. Note pus cells. $\times 400$.

CASE 4. The patient was a well developed female, age 30 years. Two years ago, she noticed for the first time a tumor in the right breast. Ten weeks prior to this admission to the hospital, a radical amputation of the breast for carcinoma was performed. The recovery was uneventful. Three weeks after the operation, she began complaining of pain in the upper lumbar back. Two weeks later swelling of the ankles and sporadic attacks of mental derangement developed. Both cleared up in 3 days, leaving the patient in fair health. Three days before admission, however, she again became delirious, slightly edematous, and developed a fever of 103 degrees F. Her condition became rapidly worse delirium progressed to coma and her entire body became more edematous. Profuse bloody stools were passed involuntarily and petechial hemorrhages appeared on both arms. The urinary output decreased and contained granular casts, albumin of plus-4, and small amounts of blood. The blood non-protein nitrogen rose to 550 milligrams per 100 cubic centimeters and creatinine to 5 milligrams per 100 cubic centimeters. The leucocytes varied between 14,000 and 16,000. The van den Bergh test was negative. Four days after admission, days after the onset of symptoms, the patient died in a clinical state of uremia.

Pathological findings. The liver weighed 550 grams. On its surface were large numbers of purplish red areas which varied from small dots to a centimeter in diameter. On section these had the appearance of multiple cavernous hemangiomas, except that they did not secrete blood in any notable amounts and were not spongy. They appeared to

be the seat of a diffuse cellular growth. These areas were somewhat irregular in outline and some of them showed yellowish foci suggesting necrosis. The liver between these nodules was mottled and reddish yellow in color. The gall bladder and ducts were grossly negative.

The kidneys weighed 145 grams each. The capsules stripped easily and the outlines of the cortex and medulla were distinct. The cortical markings were, however, extremely hazy and the whole cortex had a turgid, grayish, as often appearance.

The left ventricle of the heart contained one small, flame shaped hemorrhage under the endocardium and a number of petechial dots beneath the epicardium.

The small intestine was essentially normal, but the mucosa of the cecum was of a slate blue color and edematous. It presented numbers of small submucous hemorrhagic areas. In the descending colon, edema and surface erosions associated with interstitial hemorrhagic infiltrations were frequent. The entire large intestine was filled with bloody feces. No carcinomas there were discovered except in the liver.

Microscopic pathology. The liver sections were very unusual. In many areas the liver cells were displaced by typical cavernous hemangiomas, the blood sinuses of which were lined with a smooth row of endothelium. In other areas, groups of dilated vascular channels were found in which the stroma was infiltrated by small nests and irregular acini composed of carcinomatous cells. In many instances the dilated blood channels of these latter areas were partially lined with tumor cells. In various other portions of the liver, the tumor had assumed the ordinary appearance of metastatic carcinoma. Profuse hemorrhages had occurred in the portion of the liver uninvaded by carcinoma.

In these areas, and especially about the central veins granular disintegration and fatty changes were prominent and the liver parenchyma had been reduced to cords of anuclear hyaline cells. The general architecture of the liver had been well preserved.

The kidneys presented the picture of marked, parenchymatous degeneration. The tubular epithelium was granular swollen, ragged, and in many areas was vacuolated, anuclear and necrotic. The lumina of the tubules were filled with granular rounded masses of debris having the appearance of coalesced balls of albumin. In the medulla, the epithelial cells of the collecting tubules were granular disintegrated, and even necrotic. The intervening stroma contained small rounded bodies of either laminated or circular structures of a purple color. These were intermingled with small granules of similar color red cells, and scattered round cells. In these areas, at times the impression was created that the tubules had undergone complete necrosis. In the large intestine, hemorrhages into the stroma of the mucosa and exfoliation of the glandular epithelium had occurred. In sections taken from

the bluish areas in the cæcum and ascending colon, noted in the gross, the stroma of the mucosa contained enormous numbers of large cells loaded with iron pigment. In the areas of erosion in the descending colon, submucous œdema and polynuclear leucocytic infiltrations were prominent features.

CASE 5 The patient was a well developed female, age 64 years, who had suffered from gastro-intestinal disturbances for 10 years with attacks of gall-bladder colic every 2 to 3 months. These attacks were not accompanied by fever or jaundice. Three days prior to admission to the hospital, she had a mild attack of colic-like pain in the gall-bladder region. On admission, her liver was found enlarged to three fingers' breadth, below the costal margin her gall bladder was tender. She was not jaundiced. Four days after admission, a cholecystectomy was performed. The gall bladder was large, thick walled, and injected. It contained one large egg-shaped stone. Microscopically it showed both an acute and a chronic proliferative reaction. The day after operation, she complained of severe pain in the upper right abdominal quadrant. Her temperature rose to 105 degrees, a leucocytosis of 14,000 developed, and heavy traces of albumin appeared in the urine. The blood non-protein nitrogen rose to 46 milligrams per 100 cubic centimeters and creatinine to 2.3 milligrams per 100 cubic centimeters. Her general condition grew rapidly worse. The urine decreased in amount and contained an albumin of plus-4 and granular casts. No bleeding occurred. On the fourth day after operation the patient died in a clinical state of uræmia.

Pathological findings The liver and kidneys presented the only findings of importance. The liver weighed 1,610 grams and was of a pale grayish color except in an area about 6 centimeters in diameter extending around the gall-bladder fossa. In this area, the liver was thickened, semi-trabeculated, fibrous, and purplish red in color. The remaining bile ducts were patent and somewhat dilated. On section, the liver markings were obscured by a widespread parenchymatous degeneration. About the gall-bladder fossa, an indefinitely circumscribed area of reddish blue discoloration extended for about 4 centimeters into the liver substance. On cross section, this area presented a glassy surface with scattered areas of pale, yellowish color, producing a peculiar mottled appearance. The area was denser than normal liver.

The left kidney weighed 170 grams and the right weighed 140 grams. Both were of firm consistency. The capsules of both stripped easily. On section, the cortices were swollen and the kidney markings were quite indistinct.

There was no jaundice. No blood was found in the gastro-intestinal tract.

Microscopic pathology The liver showed considerable fatty change and marked exfoliation of the sinusoidal endothelium. Many of the sinusoids contained mononuclear and polynuclear leucocytes. Some increase in fibrous tissue was present in the

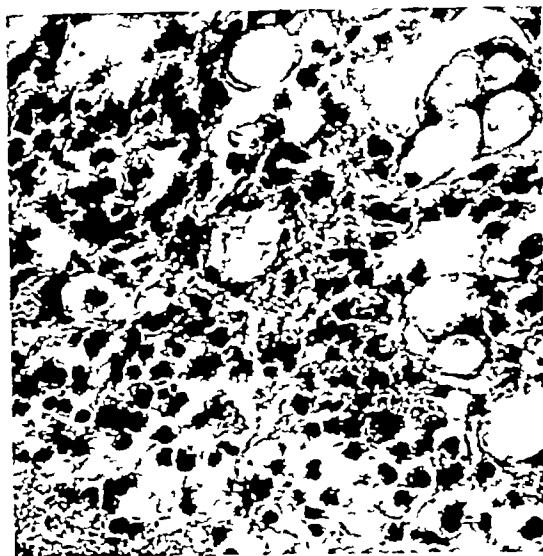


Fig 8 Case 6 Photomicrograph of liver showing leucocytic infiltration and fatty degeneration with disruption of normal architecture. $\times 500$

portal areas where monocytes were abundant. In occasional areas some regeneration and degeneration of the parenchymatous cells had occurred.

In the lungs, microscopic areas of hæmorrhagic infiltration were present in both the alveoli and the interstitial tissue.

CASE 6 The patient was a well developed female, age 56 years. She had a long history of gall-bladder disease. Several attacks of colic had been associated with jaundice. Cholecystectomy was performed 2 months prior to admission to the hospital. The gall bladder was small, sclerotic, and filled with stones. Microscopically, the picture was that of a long standing, chronic inflammatory reaction. After operation, the operative wound drained bile and attacks of colic continued. She was re-operated upon at this admission (6 weeks after original operation) and several stones were removed from the common duct. The patient died of shock 24 hours after operation. No laboratory findings were obtained after operation. Before operation, a trace of albumin was found in the urine but other laboratory findings were normal.

Pathological findings The skin was faintly jaundiced. In the peritoneal cavity, there was a small amount of free blood. The liver weighed 1,100 grams. On section, the liver lobulations were indistinct and both fibrosis and fatty changes were marked. The cut surface was somewhat dense and lusterless.

The kidneys together weighed 180 grams. Both capsules stripped with some difficulty. On section, the markings were very indistinct and the cortical surfaces were pale, lusterless, and cloudy.

Hemorrhages had occurred in only the duodenal and jejunal mucosa, but the lumen of the entire small intestine contained blood stained mucus.

Microscopic pathology. In the liver a very striking infiltration of fat was present about the portal spaces. Focal monocyte infiltration was found both in the stroma of the portal spaces and in the sinusoids. The liver cells were somewhat disintegrated and atrophic. Surrounding the gall bladder ~~lumen~~ this change was so marked that the liver tissue was scarcely recognizable. Here poly nuclear leucocytes, fibroblasts, and monocytes were abundant, and the fatty change of the medullary kidneys showed hyaline fibrosis of the medullary stroma. Throughout the cortex, patchy areas of mononuclear leucocyte infiltration and interstitial fibrosis occurred in focal areas. Isolated, streaked masses of round cells were scattered through the cortical stroma. The tubules had undergone a rather profound degenerative change with granular disintegration and vacuolization.

The liver and kidney had obviously been the seat of previous insults as attested by the fibrosis present. This was consistent with the clinical history.

In each of the foregoing cases, necropsy was performed within 2 hours after death and all examinations were complete except in Case 3

THE SYNDROME

This syndrome which we wish to describe is characterized by the following clinical and pathological findings. In most cases a history of long standing gall-bladder disease was obtained. The occurrence of this syndrome is, therefore, to be expected in later adult life. In our cases, prior to the appearance of the clinical syndrome the blood and urinary findings were normal. With its appearance the abdomen became distended the pulse increased from 100 to 120, and the temperature rose from 101 to 103 degrees F. These latter findings were soon followed by a progressive oliguria and the appearance of albumin casts and often of blood in the urine. Following these changes, the patient usually lapsed into a muttering delirium which rapidly progressed into coma and the nitrogenous elements of the blood greatly increased, while the urinary nitrogen strikingly decreased. At about this time, nausea and vomiting sometimes became prominent symptoms. These latter changes were most marked in the postoperative cases from the fifth to eighth day when with the removal of the stitches, a decided delay or even absence of wound healing was often ob-

served. Practically always some mucous surface bleeding was noted and in many instances it was so striking that the vomitus and stools consisted almost entirely of blood. The clinical picture then progressed, as a rule, to that of a profound uremia, low grade, generalized edema developed and almost total anuria followed. The retention of nitrogenous products in the blood became more marked and the patients died in a state clinically resembling uremia.

Pathological findings. At the necropsy examination generalized edema was almost always present. The operative wounds often showed little or no healing. The main findings, however were usually confined to the liver kidneys, gastro-intestinal and respiratory tracts. In all cases the liver showed obvious gross and microscopic damage. As a rule it was somewhat enlarged and fatty degeneration and profound cloudy swelling were found. Leucocytic infiltration of both mononuclear and polynuclear cells were universally present, while focal hemorrhages and parenchymatous cell necrosis were not uncommon.

The most outstanding gross findings in the kidneys were an increase in size, with obvious parenchymatous degeneration and a notable disappearance of the normal anatomical markings. Histologically tubular epithelial degeneration progressing to actual epithelial necrosis was constantly observed. Focal hemorrhages and patchy interstitial leucocytic infiltration were the rule while the glomerular changes were not noteworthy. Submucous hemorrhages were present in the gastro-intestinal tract in almost all cases and free blood was always found in the intestinal contents in these instances. It is interesting in this connection that ulcers were not found except in one case in which surface erosions were seen in the sigmoid colon. Interstitial pulmonary hemorrhages were seen in the majority of cases and other evidences of bleeding such as petechiae of the skin hemorrhages from the gums hemothorax hemothorax peritoneum and diffuse submucous hemorrhages in the renal pelvis were often found.

Jaundice was present in only 2 of our cases and in 1 of these it was only very faint and quite transient. In neither patient was there

evidence of biliary obstruction nor did the kidneys present the picture of a bile nephrosis. No gross or microscopic findings suggesting a localized infection were present in any case at necropsy.

The gall bladders which were removed at operation all showed evidence of long standing inflammation and the liver tissue adjacent to these gall bladders presented, in all instances, the most marked degree of hepatitis.

EXPERIMENTAL OBSERVATIONS

Both dogs and rabbits were used in the experiments and in all animals pre-operative, chemical, blood studies and urine examinations were made. In the dogs, we attempted to traumatize the liver without producing actual fracture of the capsule and, at the same time, to cause sufficient pulpification of the liver parenchyma to produce extensive hæmorrhagic necrosis.

It was quite difficult to cause pulpification of the liver without fracture of the capsule and several of the dogs died within 12 hours from hæmorrhage or profound shock. In this group of animals, albumin, casts, and red blood cells were found in the urine and an increase in the nitrogenous products of the blood was encountered. Due, however, to the fact that the animals lived such a short time, we did not obtain such striking rises in the blood nitrogen content or as marked changes in the urine as was noted in the clinical cases.

In the animals that lived, we obtained a rise in the blood nitrogen, albumin, casts, and red blood cells in the urine, and a progressive oliguria. These changes lasted, however, for only a few days when they gradually cleared up and the animals made an apparent complete recovery.

Necropsy examination of the animals dying within the first 12 hours demonstrated considerable parenchymatous degeneration of the more highly differentiated tubular epithelial cells of the kidney and a marked hæmorrhagic necrosis was found in the liver. In the animals that recovered and in whom the clinical picture had returned to apparent normalcy before they were sacrificed, we failed to find pathological changes of any importance in the kidney. Healing in the pulpified liver, however,

was incomplete with wide areas of hæmorrhagic necrosis in the injured regions. In these latter cases, it appeared that insufficient damage had been done to cause the elaboration of enough toxin to result in a continued kidney damage sufficient to leave any microscopic traces.

Although our experimentation has not as yet progressed far enough to form definite conclusions, we feel that our findings to date are important in that they tend to substantiate the theory that some potent poison is elaborated by necrotic liver tissue which has a specific effect on the kidney parenchyma. It is to be expected that it would be extremely difficult to produce just the correct amount of liver damage to cause a slow, progressive nephrosis such as was observed clinically in Case 2, since such a clinical picture is very rare, only two cases having been recorded (11).

Temporary ligation of the hepatic artery was performed on rabbits. One of these animals showed a very extensive type of focal coagulation necrosis of the liver, some of the areas being as much as 10 millimeters in diameter. The kidneys presented a very high grade degeneration of the tubules. The non-protein nitrogen rose from 28.5 milligrams per 100 cubic centimeters to 55 milligrams per 100 cubic centimeters of blood. Albumin, casts, and red blood cells were present in the urine and the urinary output decreased almost to anuria. In the remaining rabbits, total ligation of the hepatic artery was followed by a temporary rise in the blood non-protein nitrogen and the appearance of albumin, casts, and, in some cases, red blood cells in the urine. These changes, however, rapidly disappeared and the animals returned to an apparently normal state. Necropsy examination of the livers in these cases showed little else than fibrosis and atrophy while the kidneys did not reveal any definite pathological changes.

MECHANISM

It is extremely difficult to state just what the mechanism of this hepatorenal interrelationship is. In the toxæmias of pregnancy, a somewhat similar picture is sometimes encountered wherein the kidney damage may be so

severe as to result in their actual necrotic sequestration. Dieckmann, in an experimental study in the production of hepatic lesions in dogs, made daily injections of tissue fibrinogen into the portal vein and the peripheral circulation in some animals. In others he combined the injection into the peripheral circulation with oral feeding. In these animals, he produced lesions in the periphery of the liver lobules closely simulating the hemorrhagic necrosis of eclampsia. Some of the dogs had convulsions while others became comatose. The most interesting observation to us was the presence of typical eclamptic lesions in the kidneys of some of the animals.

Many theories have been advanced as to the manner in which the eclamptic kidney lesion is produced. Shriver and Oertel consider renal vasoparalysis to be the true causative factor while Beneke and Schmidt feel that vascular spasm with resultant ischemia produces the kidney damage. McNery and his associates by temporary mechanical pressure on renal arteries were able to cause a clinical picture in dogs closely simulating degeneration and necrosis in the kidneys is seen in cholera, and Greisinger and Leyden have held that the cholera toxin produces a vascular spasm with ischemia and subsequent necrosis.

On the other hand Ravdin obtained from the livers of dogs with experimental obstructive jaundice a very potent substance with powerful vasodepressor properties which theoretically might cause sufficient vasodilatation to produce kidney damage. Faludi, likewise, noted an apparent chemical relationship existing between the liver and kidneys in regard to water metabolism. By certain elaborate liver injection experiments, Meier was able to stimulate urinary secretion at will and thus demonstrate that the liver played a definite rôle in the stimulation of kidney activity.

We feel that bile or its products played no part in the kidney damage noted in our cases since only two were jaundiced, and in no case did the gross or histological picture resemble a so called bile nephrosis.

An evaluation of the clinical picture and the histological changes in the kidneys seem to suggest the production of a liver toxin with

a specific affinity for the kidney parenchymatous cells, in which it causes a progressive degeneration and not infrequently a complete necrosis of the tubular epithelium. The clinical manifestations of a progressive oliguria and an increasing retention of the nitrogenous products in the blood would seem to substantiate this assumption. The fact that other highly specialized visceral organs, which invariably show parenchymatous degeneration in the presence of circulating toxins, did not show the same degenerative changes as the kidney makes us feel that the toxin may act more or less specifically on the kidney.

The possibilities of embolism and thrombosis of the renal arteries were, as causative factors, of course, ruled out at necropsy in the traumatic and operative cases. Histological section failed to reveal megacaryocyte emboli which are known to occur frequently after traumatic injuries and operations. All cases were investigated for the possibility of fat embolism, but none such condition was found.

Reflex anuria as a causative factor was eliminated in our cases since they all showed a slowly progressive oliguria rather than a sudden cessation of urinary output. Furthermore none of the patients presented immediate evidence of kidney damage following the trauma or operation. In one case no possible trauma was present as the breast cancer had been removed 11 weeks prior to the onset of kidney symptoms. It is, of course, necessary to eliminate the possibility of ether narcosis causing damage to the liver in the 5 cases that received ether anesthesia, but in one of the cases no anesthetic had been administered.

The presence of mucous surface bleeding in 4 of the 6 cases may be ascribed either to action of the toxin on the capillary endothelium or to the possible decrease in fibrinogen production incident to the damage of the liver. The latter explanation is, however, largely speculative since actual proof of fibrinogen production by the liver has not as yet been satisfactorily demonstrated. The bleeding in our cases was, without doubt, of a capillary nature. In only one instance were even so much as surface erosions of the intestinal mucosa demonstrable. In the others, submucous hemorrhages were the rule.

The liver damage in two of the cases was of an obvious character. In postoperative cases, the liver lesions all had the appearance of being the result of a long standing, inflammatory reaction. All of these specimens were examined carefully to eliminate the possibility of ligation of an anomalous hepatic artery since it is recognized that such accidents often produce a rapid increase in the blood nitrogen and an accompanying hypoglycæmia. However, these individuals usually die within the first 48 hours after the operation which was true in only one instance in our series, and in none of our cases was there any visible disturbance of the hepatic arteries nor was hypoglycæmia present.

CLINICAL AND EXPERIMENTAL LITERATURE

There are a number of interesting observations both clinical and experimental which strongly suggest a very definite and close alliance between liver and kidney in disease.

Fitz-Hugh, in a clinical study, noted the nephrotoxic effect of acute hepatic obstructions with bile duct infection in 3 patients. Walters recorded the occasional occurrence of hæmorrhage, uræmia, and hepatic insufficiency in patients operated upon for obstructive jaundice. Lederer saw anuria develop in a patient with pneumococcic septicæmia and hepatic insufficiency. Barker published a case in which extensive tubular degeneration in the kidneys was present in a patient with necrosis and atrophy of the liver which he thought was due to thyroid intoxication. Walters and Parham encountered marked renal and hepatic insufficiency with intestinal hæmorrhages in some cases of obstructive jaundice. Zaffagnini noted the occurrence of hæmaturia in patients suffering from gall stones. Thiers described a case of apol poisoning with severe liver damage in which the patient had uræmia and hæmorrhages from the gums. LeNoir noted in 5 patients, who died following operation for chronic gastric ulcer, a severe hepatonephritis which came as a surprise at the necropsy. One of his patients had severe gastro-intestinal hæmorrhages which dominated the clinical picture and the hæmorrhages could not be attributed to the shriveled ulcer nor to an eroded vessel. All 3 of these

patients with liver damage had uræmia. Staehli, in a discussion of reflex anuria recorded 6 cases, all showing icterus, in whom the urine was negative prior to operation. Only one of these showed any definite signs of kidney damage prior to operation. At necropsy, the livers for the most part showed jaundice and either necrosis, purulent infiltration, or cirrhosis. The kidneys were all swollen and icteric, and presented some fatty change. In one of his patients, a high grade nephrosis with striking epithelial degeneration was found at necropsy. However bile nephrosis could not be excluded in this series of Staehli's since they all presented some degree of icterus.

In addition to the foregoing clinical observations, a number of experimental investigations have yielded evidence of a very definite relationship between the liver and kidney. Mann observed the not infrequent occurrence of anuria in dogs upon whom total hepatectomy had been performed. Allen, Bowie, McLeod, and Robinson noted vomiting and progressive decrease in urine and blood in the fæces in depancreatized dogs maintained for long periods on insulin. At necropsy, the livers of these animals showed striking fatty change and one animal in particular presented remarkable degenerative change with actual cell necrosis in the liver. This animal also had a very profound nephrosis with extensive tubular degeneration. Casts, interstitial hæmorrhages, and œdema without the presence of bile were likewise present in the kidneys. Of 2 other dogs studied, one in addition to extensive fatty change in the liver had a leucocytic infiltration of the kidney, while another showed a pyelonephritis. Gundermann ligated the left portal vein and thus obtained atrophy of three-fourths of the liver. Most of the animals died in 48 hours. Clinically, they showed fever, somnolence, frequent chills, deep respiration, and oliguria. The urine contained albumin and casts and, quite frequently, red cells. At necropsy, stomach ulcers, isolated duodenal ulcers and marked, degenerative, tubular changes of the kidneys were found. The kidney glomeruli were intact. This author also injected degenerated and healthy liver cells into the blood stream and was always able to produce a hæmor-

rhagic diathesis with bleeding into the gastrointestinal tract. He felt that the liver cell had a specific toxic effect on the blood vessels, the toxin being given off by the liver cell *in vivo*. Haberer, following ligation of the hepatic artery in dogs, observed that these animals frequently became anuric, which fact he attributed to the liver necrosis which was present. Narath anastomosed the hepatic artery and the portal vein and obtained anuria in the animals thus prepared. Furthwaengler injected autolytic liver tissue into the blood stream of animals but was unable to produce kidney necrosis. Albuminuria was a constant finding, however, and the kidneys were invariably the seat of an advanced parenchymatous degeneration. None of his animals showed complete anuria but one dog developed blood in the stool.

Whipple and Speed noted a marked decrease in the output of phenolsulphonphthalein in the urine in animals whose livers had been damaged by such specific liver poisons as chloroform and chloral. They likewise observed a similar phenomenon in dogs with Eck fistula.

CONCLUSIONS

1. Six cases are reported which illustrate what we believe to be a heretofore undescribed clinical and pathological hepatorenal syndrome.

2. Animal experiments tend to substantiate this pathological relationship.

3. The hypothesis is advanced that damaged liver tissue elaborates some potent toxin which acts more or less specifically on the kidneys.

The authors wish to express their thanks to Dr. R. M. Isenberger of the Department of Pharmacology of the University of Kansas for his generous help in carrying out the experimental work done on this problem.

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THE SURGICAL ANATOMY OF THE SO CALLED PRESACRAL NERVE

L. ELAUT, M.D., GHENT, BELGIUM

From the Department of Pathological Anatomy, University of Ghent, Belgium. Professor N. Goormaghtigh, Director.

AMONG the surgical procedures devised during the last decade for the cure of the symptom pain, which is the most prominent symptom in a series of diseases of the pelvis, one has attracted especially the gynecologist's attention, namely the operation of Cotte—resection of the postganglionic fibers of the sympathetic system which provide the innervation of the important pelvic organs—the bladder, lower part of the ureter, uterus, anus, and *mutatis mutandis*, in the male, the prostate, and the seminal vesicles.

The nerve in question has been variously named—an indication of the great confusion regarding its physiology. As to the anatomy of the presacral nerve, this has been discussed only from the theoretical standpoint as it is only lately that it has been included in the realm of surgery.

At the surgical school of Lyon where so many problems of neural surgery have been studied and new operations devised under the leadership of Leriche and others, the pelvic sympathetic system has also been studied from the standpoints of surgery and pathology.

The first important data concerning the innervation of the pelvic organs were published in 1913 by Latarjet and Bonnet. These authors also named the main nerve branches of the sympathetic system of the pelvis the "presacral nerve." This name still prevails and has become a part of the surgical nomenclature although the name does not imply the exact position or its real construction.

The surgical significance of the presacral nerve first came into prominence in 1924, when Cotte suggested performing neurotomy to relieve pain in disease of the pelvic organs, such as essential dysmenorrhœa, sclerocystic ovary. Afterward the same operation was performed to relieve the pain associated with cancer of the uterus, with cystalgia of diverse origin, with pruritus vulvæ, with vaginismus, and with dyspareunia.

We shall not discuss the clinical side of the problem or review the literature, for this has

already been done in some excellent papers—most of them in French periodicals. We would refer particularly to the 1931 edition of Cotte's book entitled *Troubles fonctionnels de l'appareil génital de la femme* or to the work of Michon and Haour. It seems from the study of different surgical papers that the operation of Cotte is still a matter of open discussion among clinicians and that it will not be settled very soon.

The purpose of this paper is to give an accurate description of the region in which neurotomy of the presacral nerve is performed and to call special attention to some important facts as to the surgical anatomy of this nerve. This paper is based upon a study of 50 cases. The bodies were carefully dissected and every detail was noted on an appropriate schema during or soon after the work was done. We directed our attention chiefly to the following points, which, in our mind, should be kept in mind in performing a Cotte operation.

1 The anatomy of the nerve and its branches, their origin, division, and endings.

2 Particular position of the nerve in the frame of the interiliac triangle, its relation to the neighboring organs such as the aorta, the iliac arteries and veins, the inferior mesenteric artery and veins, the middle sacral artery, the ureters, sacrum, and peritoneum.

ANATOMY OF THE SO CALLED PRESACRAL NERVE

The name "presacral nerve" as stated previously, does not imply a definite anatomical entity which has taken its place in the scientific nomenclature. In the very extensive treatise of Hovelacque on the anatomy of the cerebrospinal and sympathetic nervous system, it is called the "plexus hypogastricus superior." Tiedemann gave it the name of "nervus uterinus magnus."

Origin. On the lateral margin of the anterior wall of the abdominal aorta, from the origin of the superior mesenteric artery down to the origin of the inferior mesenteric artery,

two nerves may be seen. The nerve formations are arranged in two parallel bundles with, from time to time an oblique anastomosis running across the aorta and rejoining its partner on the opposite side. The bundles sometimes run together on the anterior wall of the aorta for about 1 centimeter whereupon they again separate. To these intermesenteric nerve branches—intermesenteric nerves of Petit Dutailla and Flandrin—add the anastomoses coming from the lumbar sympathetic chain. At the level of the origin of the inferior mesenteric artery the intermesenteric nerves divide into two distinct bundles, one, the inferior mesenteric plexus running along the artery itself gives off a thin arborization of nerves located within the arterial walls of the mesenteric vascular system, the second branch continues straight down on the anterior wall of the lower aorta and below of Hovelacque. This plexus still consists of two main bundles. In both bundles several fine branches may be detected and separated from their neighbors. The two main bundles are parallel at a distance of about 1 centimeter from each other but have a very definite tendency to join so as to make a distinct branch.

This description is in complete accord with our own findings. A discrepancy arises however when we consider the description of Latarjet and Bonnet. These authors make a distinction between two sympathetic chains, the laterovertebral chain and the prevertebral chain. While the aorta divides into the common iliac arteries in like manner. Most of the nerve elements assemble to form a compact and irregular cord made up of compactened and irregular short anastomoses and a fasciculi united by short anastomoses and a dense connective tissue. Thus the hypogastric plexus begins with a true nerve—it may be seen easily in young and emaciated individuals. This nerve goes down in a direction parallel with the midline it crosses the iliac vein rises over the prominence of the anterior surface of the sacrum. The presacral connective tissue becomes dense around the nerve and thus holds it together. After it

reaches the pelvis, at a distance of 4 to 6 centimeters, the presacral nerve separates into two branches—the hypogastric nerve.

This description is too schematic and as a matter of fact not in accordance with the anatomical findings. However we cannot lay too much stress on the great variability of the superior hypogastric plexus (presacral nerve) and on the extensive stretching of the elements over the promontory—it is not exceptional to see them over an area of several centimeters. These facts should not be lost sight of with regard to surgery of the nerves, in fact, we believe that poor results may occur from disregarding these essential anatomical data.

In our series of 50 cases, we noticed only 1 in which a nerve formation in the sense of a distinct nerve was present. In all the other cases there was a definite intricate network of nerve fibers. And when we say distinct nerve, does this not mean a nerve as we are accustomed to see it in the hand or any other part of the body? In the most favorable cases of a distinct nerve we were able to recognize with the naked eye and, without the help of any instrument whatever to isolate several parallel running branches, bound up in a connected mass about a half centimeter in diameter. The length of this so called nerve was only 2 centimeters. In all the other cases the nerve was still shorter being merely 1 centimeter at the point at which the branches met before they separated again.

In naming this nerve formation, the use of the term nerve is inappropriate and erroneous, but the use of the anatomical name plexus (after Hovelacque) is correct as it gives an accurate, exact idea of the construction of these nerve formations. The superior hypogastric plexus itself is subject to great variations so that it is difficult to give an exact description of all the different types we have encountered. We shall try however to give a picture of our findings. The plexus has the shape of an elongated triangle, with the top directed toward the diaphragm. The two lower angles from 1 to 3.5 centimeters apart, correspond to the origin of the hypogastric nerves. The central area of

the triangle is occupied by the numerous anastomoses which run from side to side. The sides of the triangle represent the chief branches of the intermesenteric nerves. Usually the trigone is made up of three main branches which run together, one at the very top, the two others joining the triangle a few millimeters lower.

This triangular mass receives a series of secondary connections from other regions: first, from the inferior mesenteric plexus which lies within the pelvic mesocolon at its left—these are very thick branches and join the plexus at various points, second, from the last ganglion of the lumbar chain, which lies within an inch of either side of the lumbar column.

It is not unusual to find another type of plexus in which the branches come straight down and remain isolated without going into the typical plexiform network we have described, the two or three chief branches running for a distance quite close to each other and then separating again. Some very frail anastomotic fibrils connect the two main nerves obliquely. In this type also the triangular shape of the whole plexus formation may again be borne in mind.

In many instances the connective tissue has been mentioned and not without good reason, because it is of real interest from the surgical standpoint. The loose areolar subperitoneal tissue becomes denser in the neighborhood of the plexus so as to form a rather compact covering membrane around the different nerve fibrils, holding them together in a fan-shaped ensemble, where the nerves are as the veins of a leaf, the whole resembles a goosefoot. This arrangement makes it easy to lift up the entire plexus which looks like a flat ribbon.

Segond gives in his thesis a different picture of the superior hypogastric plexus. He describes the plexus as four or five parallel nerves which leave the aortic area and, close to the promontory, encounter another nerve formation which resembles an arch. The legs of the arch are the two hypogastric nerves. In our series of 50 anatomical dissections, we met once with this type of presacral nerve, the branches were parallel to each other until they reached the arch and were about 1 centi-

meter apart. The whole formation is about 4 centimeters wide. The connective tissue is rather loose around this type of nerve.

The multiplicity of nerve elements which constitute the so called presacral nerve may finally be proved by making a transverse section through all the tissues of the region. Such a section is shown in Figure 6. There are visible at least four or five separate islets of nerve tissue which are lost in the subperitoneal fat infiltrated membrane and have no reciprocal connections.

Reviewing our 50 dissections we find 12 cases with distinct nerves, 8 cases with parallel fibers, 29 cases with typical plexuses, and 1 case with an arch-shaped plexus.

In our series there were 4 newborn infants in all of whom the presacral nerve was found to be a plexus. Referring to the literature on the subject, we find contributions by Hartmann-Weinberg, Kalberg, Delmas, and Roussel. The first of these authors investigated the abdominal aortic plexus (the intermesenteric nerves of Petit-Dutailis and Flandrin) in men and apes, and he found it to be also a real plexus instead of a distinct nerve. In a thorough study, Kalberg laid great stress upon two points. The absence of a sharp demarcation between the aortic plexus and the superior hypogastric plexus. The presacral nerve is only one type of the superior hypogastric plexus. It is the result of a union of the more or less symmetrical sympathetic chains of both halves of the abdomen. Delmas tried to discover where the different branches of the presacral nerve originated. He assumes that the nerve is made up chiefly of branches originating in the two first lumbar ganglia and secondly of branches from the aortic plexus. Roussel's statistics are not in agreement with our own. He found, in 75 per cent, a distinct narrow cord, in 20 per cent a flat plexiform ribbon, in 5 per cent a plexus with large openings, whereas Kalberg, to quote literally says "The presacral nerve is very seldom to be seen in man, it merely exists as a plexus." Rouffart has also been struck by the numerous variations in the nerve. He has found instances in which the different nerve elements occupied the entire area situated between the two common iliac arteries.

Endings of the nerve At one part or another in its course, the presacral nerve divides into two very distinct branches the right and left hypogastric nerves. These are real nerves and contain white nacreous fibers which may easily be dissociated. These too have received various names although they are now universally known as hypogastric nerves. Delmas, however proposed recently to call them the pelvic splanchnic nerves." Though the hypogastric nerves do not follow exactly the course of the hypogastric arteries and are situated inward and at a reasonable distance from them, they have the same general direction of the blood vessels—they go down into the depth of the pelvis until they expand on either side of the important pelvic organs and form a new plexiform network more important than that from which they originated, the inferior hypogastric plexus. The hypogastric nerves run under the peritoneum. In a part of their course they are situated on the lateral margins of the anterior surface of the sacral bone and later they are one of the elements of the lateral wall of the pelvis. There are a few thin anastomotic branches rejoining the two symmetrical nerves. These anastomoses run across the sacrum in a slightly oblique direction. There are also uniting fibers coming from the inferior mesenteric plexus and going as well to the right as to the left hypogastric nerve.

PARTICULAR POSITION OF THE NERVE

In order to give an accurate description of the operative region and to establish the important features of the surgical anatomy of the presacral nerve, it is necessary to point out certain fixed marks. An easily definable trigone is the best way to locate the nerve. This trigone may be described as follows: the bottom corresponds to a line joining both common iliac arteries at the level of the promontory these arteries being the sides of the trigone, its top lying in the bifurcation of the aorta. We have called this area the interiliac trigone. It is situated at the level of the fifth lumbar vertebra, the last intervertebral cartilaginous disc, and the lower third of the fourth lumbar vertebra. The two common iliac arteries at the promontory line are about

7 centimeters apart. The distance from the top of the trigone to its base is nearly 6 centimeters. It may vary in accordance with the peculiarity of the branching aorta. The interiliac trigone has another exceedingly important characteristic. A large part of the left half of the trigone is occupied by the left common iliac vein which branches off from the vena cava, comes from underneath the right common artery and runs parallel with the lower margin of the left common artery. The walls of the vein are thin and may very easily be injured by instruments. In the depth of the interiliac space is another important organ—the arteria sacralis media. This artery courses exactly through the midline of the trigone and divides it into halves. It may be felt by the exploring finger tip. On many occasions and by many surgeons it has been mistaken for the presacral nerve. We have endeavored in all our cases to identify the nerve by feeling about in the interiliac space but we were not successful. What we did feel was not the nerve but the arteria sacralis media. In very much emaciated bodies where with the naked eye the nerve elements could easily be seen through a transparent peritoneum we were unable to identify them with the finger. This point should be emphasized.

Grossly the presacral nerve is parallel with the middle sacral artery and descends straight down from the top of the trigone toward its base. At the lower part of the aorta from the origin of the inferior mesenteric artery up to the bifurcation, the nerve elements of the presacral nerve are in intimate contact with the aorta there being only a thin connective coat between the two thus allowing them to be separated easily with the knife or scissors. When the hypogastric plexus leaves the aorta and passes on to the left common vein, the adhesions with this vessel become looser the underlying connective stratum is soft areolar tissue which makes it possible for the nerve to be lifted up with its entire framework of anastomoses and divisions. Still lower down the nerve lies on the periosteum and perichondrium of the fifth lumbar vertebra and the cartilaginous disc between this vertebra and the sacrum. At this point of its course the nerve is exactly above the middle sacral

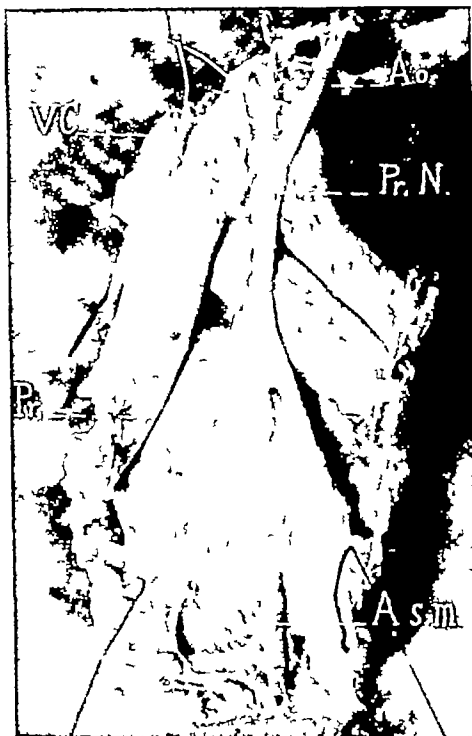


Fig 1 Fresh preparation of the presacral nerve which shows as a single nerve branch situated at the aortic bifurcation. At the level of the promontory, *Pr*, the two hypogastric nerves are distinctly separated, connecting branches may be seen between both nerves. The middle sacral artery, *A. S. M.*, is lying beneath the nervus formation.

artery with its two homonymous veins, being separated from them by a loose connective mass. Here too the nerve is a plexus in the fullest sense of the word.

It happens frequently, in fact in about one-third of the cases, that large branches of the nerve are found in the left half of the interiliac trigone but none of them in the right half. In these cases the intermesenteric nerves also lie on the left margin of the aorta instead of on the anterior wall. The position of the nerve is definitely lateral—in a few cases in fact the nerves were nearly adjacent to the left common iliac artery.

The entire interiliac trigone is covered with peritoneum, which continues and extends over the anterior surface of the sacrum. Consequently the nerve lies between the peritoneal membrane and the underlying bones. The

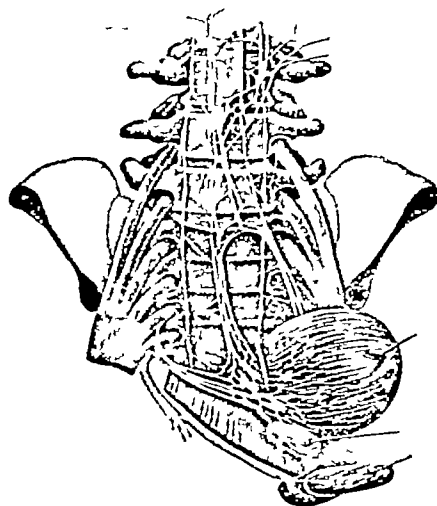


Fig 2 Schematic view of the sympathetic nervous system and its distribution in the pelvis of man. After L. Mueller (*Lebensnerv und Lebenstrieb*. Springer, Berlin, 1931).

nerve does not adhere to the peritoneum. Several surgeons, however, who have written on this subject, have stated that there are adhesions of the deep peritoneal surface to the nerve plexus. In all of our cases it was possible to seize the peritoneum with the forceps without producing any displacement of the nerve, even in those cases in which the subperitoneal fat infiltration was absent. The peritoneum may easily be dissected from all the underlying tissues. The space between the nerve and the peritoneum is more or less infiltrated with fatty tissue depending on the obesity of the patient. Fatty tissue also surrounds the windowed plexiform nerve structure. Transverse sections show very clearly the relation of the different elements of the interiliac trigone (Figs 6, 7, 8, 9).

The inferior mesenteric vessels, which are situated in their mesenteric bed, and more especially the branches going to the sigmoid colon and the upper part of the rectum, are sometimes in direct and intimate relationship with the presacral nerve. This relationship is dependent upon the particular anatomical position and the length of the pelvic meso-

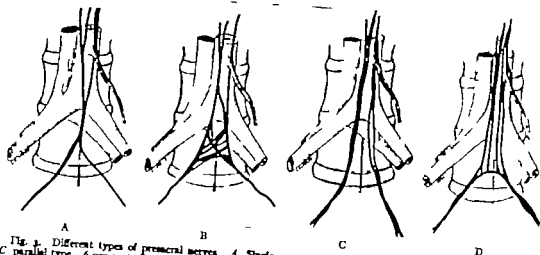


Fig. 3. Different types of presacral nerves. A. Single nerve type, 24 per cent. B. plexus type, 58 per cent; C. parallel type, 6 per cent. D. arch-shaped type, 8 per cent.

colon, the right root of which is inserted on the midline or still further to the right. In these particular cases, the nerve and vascular elements of the mesocolon are situated just in front of the interiliac trigone. Hence the presacral nerve can be reached only through the thick mass at the bottom of the mesocolon—a procedure difficult of accomplishment and carrying with it the danger of injury to the important vessels running through this part of the pelvic mesocolon (Fig. 4).

There was one other very confusing fact the nerve could not be detected at its usual site in the interiliac trigone for it had followed the course of the mesenteric plexus high up into a long floating mesocolon and had descended thence into the pelvic cavity after it had divided into the two hypogastric nerves. Such a peculiar position was found only once in our series of 50 cases.

One must bear in mind a certain anomaly of the blood vessels occurring not infrequently within the interiliac trigone. In our rather small series of cases we met this condition twice, namely a large, pencil size vein arose from the left common iliac vein, proceeded directly across the trigone and joined the opposite wall of the pelvis at a spot close to the bifurcation of the common artery. The vein lay on the periosteum the nerve crossed it obliquely being adherent in a few places.

What is the position of the nerve with regard to the promontory—a matter of marked importance in surgery of the pelvis? What is its relation to the sacrum? One would expect to find the nerve in front of the sacrum as implied in the term "presacral." We may say that we have never found it in front of the sacrum, but it has always been above the promontory in front of the body of the fifth lumbar vertebra and the intervertebral cartilaginous discs below and above this vertebra. In other words, the nerve is always "prelumbar." Exceptionally the nerve divides into its two hypogastric branches exactly at the level of the promontory.

In these rare instances the two hypogastric nerves, before they reach the lateral pelvic wall traverse the surface of the sacrum but only at the upper angles of the bone, not at the midline. When the position is definitely lateral so that the nerve is along the left common artery the right hypogastric nerve crosses obliquely the anterior concave surface of the sacrum descending from the level of the left sacro-iliac joint toward the third sacral opening at the right while the left hypogastric nerve continues straight down along the left vessels to join the inferior hypogastric plexus and ganglion.

The bifurcation of the presacral nerve is also liable to have many variations. As pre-

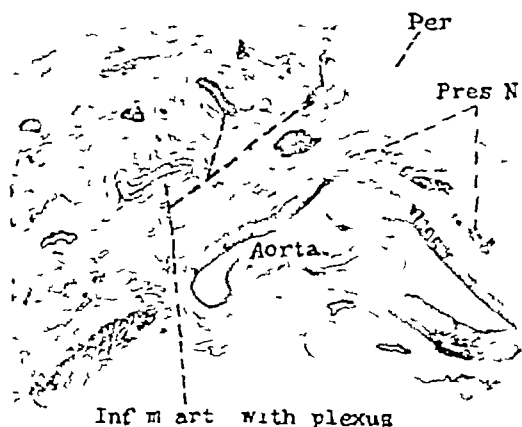


Fig 4. Cross section of the pre aortic region of an adult man. The aorta is seen exactly at the spot where it divides. The inferior mesenteric artery and its branches are surrounded by the elements of the nerve plexus of the same name. The presacral nerve in this particular case is of the "plexus" type since it is seen as numerous small and separate islets of nervous tissue. The vicinity of the mesenteric vessels and the presacral nerve is to be noted.

viously stated, there is no accurate definite splitting point, if we consider that the two constituent hypogastric branches are already separated and recognizable in the nerve proper. Notwithstanding, the two nerves open at a given moment but not always at the same point. Sometimes the bifurcation is very high at the same level at which the aorta gives off the two common arteries, more often it is below this spot, but seldom at the base of the trigone. However, thin nerve branches may be seen crossing the anterior surface of the sacrum occasionally the right hypogastric nerve, nearly always connecting branches of the two hypogastric nerves, and very frequently anastomotic branches from the inferior mesenteric plexus.

Some surgeons have mentioned possible difficulty with the ureters. This might be true in those exceptional cases in which it is necessary to pull the pelvic mesocolon to the left in order more easily to reach the interiliac trigone. The right ureter is the one in which we are interested, for the reason that the right ureter is adherent to the deep peritoneal surface, whereas the nerve does not adhere to the peritoneum. This fact that the right ureter is adherent to the peritoneum and the

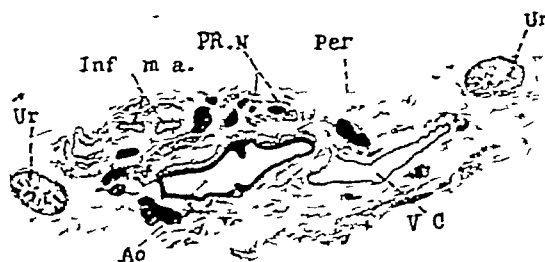


Fig 5. Cross section of the pre aortic region of the newborn, shows very distinctly both ureters, *Ur*, at the edge of the preparation. Aorta, *Ao*, and vena cava, *V C*, may easily be recognized, also the inferior mesenteric artery, *Inf m a*. The presacral nerve, *Pr V*, is seen as separate islets of nerve tissue.

nerve is not, enables one to differentiate the ureter from the nerve. Any interference from the left ureter in locating the left presacral nerve is hardly worth mentioning because the ureter is outside the region and is covered by the vessels and nerves of the mesocolon.

IMPLANTATION AND POSITION OF PELVIC MESOCOLON

Even though numerous authors have failed to mention the subject, the implantation and position of the pelvic mesocolon should be analyzed. The interiliac trigone is covered with peritoneum which on the right is reflected back on to the lateral walls of the pelvis and spreads over the anterior surface of the sacrum, while on the left at the border line of pelvis and abdomen it envelops the sigmoid colon and the upper part of the rectum whereupon it is again reflected on to the anterior abdominal wall. Sometimes, after the two peritoneal membranes have wrapped around the intestinal tube, they come very close to each other so as to make a true mesentery, the pelvic mesocolon. Between the two peritoneal layers run the vessels and nerves of the bowel.

The anatomical construction of the pelvic mesocolon may thus be very long, 10 or more centimeters. The result is a floating sigmoid which may reach up to the cæcum. Occasionally the mesocolon is inserted on the posterior abdominal wall at the level of the promontory and the lower lumbar column, and the two peritoneal sheets are wide open so that they cover the entire surface of the

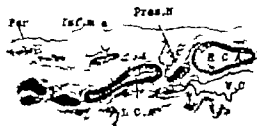


Fig. 6. Cross section at the level where the aorta has already divided in the two common iliac arteries. The numerous islets of nerve tissue situated between these two vessels correspond to the presacral nerve. The inferior mesenteric artery (Inf. m. a.) is seen with its nerve plexus exactly in front of the left common vein.

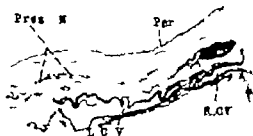


Fig. 7. Cross section of the region at the level of the promontory. The presacral nerve is seen in front of the left common vein midway between the peritoneum, Per, and this vessel.

interiliac trigone in this particular case the right borders of the mesocolon reach close to the right ileosacral joint.

In summarizing the topography of the pelvic mesocolon in relation to the performance of a neurotomy of the presacral nerve three different possibilities should be emphasized.

1. The presence of a short mesocolon which does not interfere with exposure of the interiliac trigone.

2. The presence of a long mesocolon which reaches hardly to the trigone but which is apt to be shifted aside so as to allow the region in which we are interested to be exposed freely.

3. The presence of a long mesocolon the root of which extends over the base, covering the entire trigone. This peculiar situation of

the mesocolon makes any direct exposure of the trigone impossible.

In our series of 50 cases, 78 per cent were in the first class, 14 per cent in the second, and 8 per cent in the third.

SUMMARY OF ANATOMICAL DATA AND SURGICAL INTEREST

We wish to emphasize the most important data of this anatomical study as applied to Cotte's operation of presacral nerve resection.

1. The presacral nerve is never "presacral." It is always prelumbal. It is situated in the triangular space formed by the common iliac arteries and the line of the promontory.



Fig. 8. Cross section of the region at the level of the promontory in case of low branching nerve: four very distinct nerve islets may be seen. The midline is indicated by the art. sacralis media, Art. s. m.; the nerve is on the left half of the interiliac trigone.

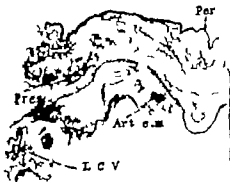


Fig. 9. Cross section of the region at the level of the sacrum (second sacral vertebra). The nerve elements seen at the left edge of the preparation are the left hypogastric nerve. Exactly at the midline in front of the art. sacralis media, there are no nerves.

2 It is quite exceptional to find a true nerve. In a very high percentage of cases, what should be the nerve is merely a plexus. Whatever its construction it resembles an elongated triangular ribbon which is a dense connected mass with interwoven nerve fasciculi. The nerve varies in length. It begins approximately at the point where the abdominal aorta divides into the common iliac arteries and very soon splits into two branches—the hypogastric nerves. These branches descend behind the peritoneum toward the side walls of the pelvis. In one-third of the cases the nerve occupies the left half of the interiliac trigone. It always runs over the left common vein. At the level of the promontory the two hypogastric nerves are always distinct entities. Sometimes the right hypogastric nerve may cross the concave surface of the sacrum, however, the nerve itself never does.

Neither the presacral nerve nor its two branches are adherent to the peritoneum, which may always be lifted up without producing any traction on the nerves. The right ureter, however, is adherent to the peritoneum—a fact which must be kept in mind in surgical procedures to expose the nerve.

In about 8 per cent of cases the pelvic mesocolon is inserted exactly in front of the interiliac trigone so that the nerve cannot be reached by a simple incision of the peritoneum. In such cases the chief branches of the inferior mesenteric artery must be moved to the left so as to expose the triangular space between the two common iliac arteries.

We suggest the following procedure as an easy and reliable method for the complete exposure of the nerve. Through a vertical incision of the peritoneum exactly at the level of and below the aortic bifurcation a search is

made of the nerve elements at the aortic bifurcation, their frequent lateral position being kept in mind. Then the whole nerve formation is grasped with an appropriate instrument and traction is exerted so as to raise the branched network of the nerve mass. If these steps are carried out there is obviously less danger of injury to the important vessels of the region and an increased guarantee of being able to perform a complete neurotomy since no important branches will be overlooked.

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TUMORS OF THE APPENDIX¹

WILLIAM B. NORMENT, M.D. M.S. GREENSBORO, NORTH CAROLINA

IN this study of a series of tumors of the appendix are included carcinoma, myxoma, angioma, and mucocele.

In 1903 Elting reviewed all the literature and analyzed all cases of primary carcinoma of the appendix which had been reported to that date. He found only 23 including 3 of his own. Bunting in 1904, drew attention to the histological and morphological similarity between primary tumors of the appendix and the basal cell epitheliomata described by Krompecher. In 1907 Oberndorfer suggested the term "carcinoid" for this group of tumors because of uncertainty concerning their origin, and to distinguish them from true carcinomata. Gosset and Masson, 7 years later after applying silver nitrate impregnation methods, described the growths in their cases as originating from cells in the depths of the crypts of Lieberkuhn. Their view was confirmed by Hasegawa in 1923 and by Danlach in 1924.

Glazebrook, in 1895 was the first to report sarcoma of the appendix. Up to the present time 20 cases have been reported.

Intra-appendiceal polyps were observed by Vanden Berg. Royster cited 3 other cases, those of Vogel, Flanu, and Setkowsk. Kelly's book contains a record of 4 cases. Myomata, fibromata, and myxomata have been found but are exceedingly rare.

Féré was the first to apply the terms "retention cyst," "hydroma," or "mucocele" to that portion of the appendix in which dilatation had occurred. The condition was first recognized by Virchow in 1836 and he considered his case as one of colloid degeneration of the appendix. In 1916 Dodge made an exhaustive study and found only 142 cases reported in literature.

MATERIAL AND ETIOLOGY

From a series of approximately 45,000 appendices used in this study 67 were found to be carcinomatous. The youngest patient who had carcinoma was 5 years of age the old-

est, 80 years the average age was 38 years. McWilliams, in a review of 78 reported cases of carcinoma of the appendix, stated that 60 per cent of the patients were less than 38 years of age. All authorities agree that the average age of patients who have carcinoma of the appendix is much lower than that of patients with carcinoma of any other part of the gastro-intestinal tract. The distribution of the cases of appendiceal carcinoma of the present series, according to decades of life, was as follows: first decade, 1 case; second decade, 6 cases; third decade, 16 cases; fourth decade, 16 cases; fifth decade, 17 cases; sixth decade 4 cases; and seventh decade, 8 cases.

Cysts of the appendix occurred irrespective of any specific age limit. Of patients with mucocele the youngest was 4 years and the oldest, 65 years of age the average age was 41 years. Of the 36 patients of the present series who had cyst of the appendix 1 was in the first decade of life, 3 in the third, 12 in the fourth, 11 in the fifth, 7 in the sixth, and 2 in the seventh.

Pfemister has expressed the view that there is definite relationship between development of cysts of the appendix and normal involution of the appendix for most of the patients are between the ages of 35 and 50 years, the period in which retrogression, with obliteration of lumen of appendix takes place (Fig. 1).

MacCarthy and McGrath, in a review of carcinomata of the appendix in 1911 found that 73 per cent were in females. In the present series, 67 per cent were in females. All observers agree that there is a higher percentage in females. Sixty-one per cent of the patients who had mucocele of the appendix were males. Myxomata, polyps, and fibromata were about evenly divided between the sexes.

The recent change in viewpoint of pathologists regarding the etiology and origin of carcinomata of the appendix is of considerable significance. The outstanding opinions have been advanced by German and French writers and may be summarized as follows: (1) The

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tumors represent true carcinoma derived from epithelium of the gastro-intestinal mucosa, (2) they may be considered analogous to basal cell carcinomas of the skin, (3) they may be malformations, belonging to the general group of tumors developing from pancreatic cysts, such as adenomyoma and accessory pancreas, and (4) they may be derived from chromaffin cells of the crypts of Lieberkuehn. Forbus, by using silver nitrate stain, gave support to the fourth theory. My study of these tumors, based on similar staining methods, indicates apparently definitely that their origin is from these cells.

The association of inflammation with carcinoma of the appendix was emphasized by MacCarty and McGrath. It is accepted by all writers as the foremost exciting cause. In this study, 7 carcinomata occurred in appendices that were the site of subacute inflammation, and the remainder in appendices that were chronically inflamed; 90 per cent were found incomplete or partially obliterated.

The principal etiological factors in production of solitary mucocoele may be classified as intrinsic and extrinsic. (1) the normal involution or obliterative process occurring at some point between a secreting area and the base of the appendix, (2) general proliferative and ulcerative inflammatory processes, and (3) extrinsic causes, such as pressure and kinking of the appendix. Regardless of the ultimate cause, it is evident from a study of appendiceal cysts that they are immediately due to retention of normal or altered products of secretion, to which may be added, later, products of degeneration.

PATHOLOGICAL CHARACTERISTICS

Carcinoma. Grossly, 34 per cent of the appendices which contained carcinomata were symmetrically dilated at the situation of the growths. The growths were in the distal one-third of the appendix. In 21.5 per cent there was irregular dilatation. In the remaining appendices there was no alteration in form, and only by sectioning were the tumors discovered. Only a relatively small percentage were larger or smaller than normal. Ten per cent were smaller than normal, 17.6 per cent were larger, and 72.4 per cent were of normal

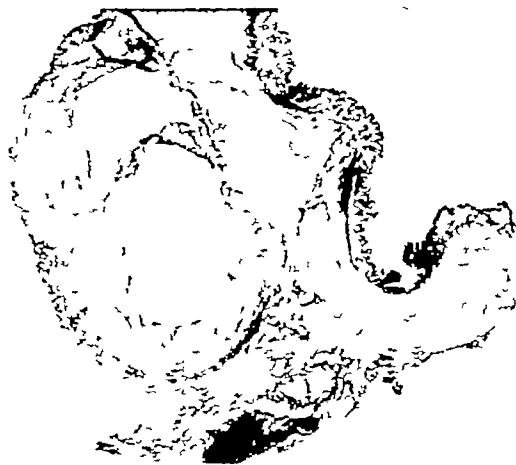


Fig 1. Large cyst of the appendix, independent of lumen (X6)

size. The serosa was normal in color in 94.2 per cent, and was congested and darker than normal in 5.7 per cent. There was complete or partial obliteration of the lumen in the majority of specimens. In 76 per cent, the distal one-third was obliterated. Obliteration of the entire lumen occurred in 23 per cent. Among the entire number of 45,000 appendices, carcinoma occurred in 1 of every 53 in which the lumen was partially or completely obliterated. Examination of the mucosa in regions where there was no obliteration grossly did not reveal any unusual characteristics. Of the appendices which were the site of carcinomata, in 90.2 per cent there were prominent irregularities, possibly due to associated inflammation. There was no evidence of ulceration. Gross evidence of extension of the carcinoma through the serosa, consisting of the presence of an orange colored area over the surface, was seen in 11.7 per cent. The typical orange colored appearance of the growth, when sectioned, was seen in 80.4 per cent of them. The growths were grayish in 19.6 per cent. The average length of the tumors was 8.1 millimeters, the average width, 5.2 millimeters, whereas the average measurements of the appendices with carcinomatous involvement were length, 6 centimeters and width, 6.6 millimeters. The growths were in the distal one-third in 92.2 per cent and involved the entire lumen in 7.8 per cent (Figs 2, 3, and 4).

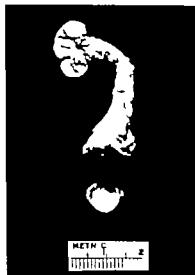


Fig. 2. Carcinoma of the appendix.

The frequency of occurrence of carcinoma of the appendix is given by different pathologists as from 0.3 to 0.6 per cent. Probably the most widely accepted percentage is 0.4. The relation of carcinoma of the appendix to carcinoma of other parts of the intestinal tract is as 1 to 250.

Histologically these tumors have previously been classified into main groups, namely the spheroidal cell type and the columnar cell type.

Most carcinomata of the breast contain columnar cells in addition to the predominating spheroidal cell. Both types of cell may also be seen in the stomach. It appears, therefore that although some cells attain their typical columnar form in carcinomata of the appendix most of them have not advanced in development beyond the premature spheroidal shape.

Of carcinomata of the appendix in the present series, 2 were of the columnar cell type whereas those remaining were of the small, round-cell type. In cross section of the latter type, the lumens were found to be obliterated, and the normal mucosa of about 40 per cent of them was replaced by an equal proportion of glandular nests and connective tissue. In about 30 per cent, the growth was composed mostly of connective tissue stroma, with few

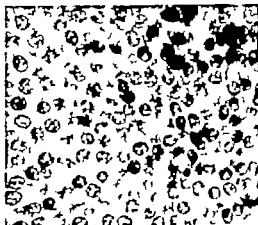


Fig. 3. Carcinoma of the appendix, showing nuclei and granules ($\times 800$).

carcinomatous nests. In the remaining 30 per cent the lumen was obliterated by a pre dominance of nests and strands of polygonal cells, over a very scant connective tissue stroma.

Some groups of cells were round some, irregular some oblong and some, long. The majority of them were round or oval. The cells in the nests were mostly closely packed. The remainder were in a disorderly and loose arrangement. In sections of 10 of them there was the normal, glandular structure. Seven of these 10 revealed some form of degeneration, such as cloudy swelling, vacuolization, and so forth. The majority of the carcinomatous nests also gave evidence of degeneration which probably explains why in some of the groups, there were fewer cells with disorderly arrangement. Each component or alveolus, consisted of from 20 to 200 cells when seen in cross section. The large glandular masses were confluent and the majority of the glands were solid. Many contained vacuolated bodies of various sizes, simulating lumens. In 90 per cent of the cases of carcinoma, there was complete invasion of the submucosa. In 15 per cent the submucosa was the limit of extension. In 80 per cent there was extension of the cells without the groups. The circular muscle was invaded in 75 per cent and the longitudinal muscle, in 75 per cent. The masses were possibly accumulations of secretory material.



Fig 4 Carcinoma of the appendix ($\times 60$)

Their size determined the relationship of the cells to the stroma. When a number of the vacuolated bodies had become confluent near the center of the glandular component, the cells were crowded toward the stroma and the glandular mass assumed true acinous formation. As a rule the vacuolated bodies were distributed irregularly throughout the glandular component, giving it a honeycomb appearance. The smaller glandular units were surrounded by a definite basement membrane.

Polyp Two polyps were found in this series. One small growth was in the middle one-third of the appendix, in conjunction with a mucocele, the other was found at the base of the appendix. They consisted of mucous membrane and a small portion of submucosa. The glands of Lieberkuehn, the stroma, and the lymph nodes were well preserved. It is probable that the former polyp was an etiological factor in production of the mucocele. It did not produce complete obstruction, but prevented normal drainage of the appendix.

Myxoma There were only 3 myxomata in the collection of tumors of the appendix. The cells produced a stellate appearance, with a tendency toward branching cytoplasmic processes. Rarely, some of the cells contained multiple nuclei, which were separated from each other, as is often seen in myxomata. In none of the sections was there a definite line of encapsulation (Fig 5).



Fig 5 Myxoma of the appendix

Venous hæmangioma This type of growth is rare in the appendix, but one specimen was seen. Grossly, it appeared as a mottled, brownish area over the surface of the appendix. On section it resembled somewhat a sponge, and was reddish in color. Microscopically it consisted of a network of vessels partially filled with blood. The lining cells were large and swollen. In some instances the smaller spaces were completely filled with endothelial cells. The greater part of the growth was confined to the muscular layer and serosa. This is the only venous hæmangioma of the appendix reported in the literature (Fig 6).

Mucocele The largest mucocele recorded in literature is that reported by Neumann, described as being the size of a man's head. Kelly described one the size and shape of a banana, curved at its base, and 30 centimeters in length. The content of such cysts is serous, mucoid or colloid, and of yellow or gray color. When sections of mucoceles of the present series were fixed in picric and acetic acid for 16 hours, washed in running water for 12 hours, and then stained with mucicarmine, it was found that the substance in the spaces took the pink stain of pseudomucin rather than the expected blue stain of mucin. When stained with safranin, the same results were obtained.

Osterberg obtained a positive test for pseudomucin from contents of these cysts, using Hammarsten's method, as follows. Given amounts of fluid were diluted with equal



Fig 6 Venous angiosarcoma of the appendix (X15)

amounts of distilled water faintly acidified with acetic acid, boiled and filtered. This clear filtrate free from coagulable protein or any mucin that may have been present was evaporated to a small volume, cooled, and five times its volume of absolute alcohol added. The resulting heavy precipitate was filtered off, washed with absolute alcohol and redissolved in distilled water. Then this was tested for pseudomucin by hydrolyzing with an equal amount of 10 per cent hydrochloric acid on a water bath for 2 hours until the fluid became clear and of a brownish color. It was then filtered and on neutralization with 40 per cent solution of sodium hydroxide, gave a well marked reduction of Fehling's solution.

Mucocoeles are known to contain true mucin, and even when the cells become histologically altered, as in carcinoma of other organs, they still continue to secrete mucin and not pseudomucin (Fig 7).

ASSOCIATED CONDITIONS

Cholecystitis was the associated pathological condition that was found most frequently in this series of tumors of the appendix. However the proportion of cases in which the gall bladder and duodenum are involved in cases of appendicitis is higher than in cases of tumor of the appendix. Eusterman, in a large series of cases of gastric and duodenal ulcer found that in about 40 per cent there was disease of the appendix. Deaver stated that 90 per cent



Fig 7 Mucocoele of the appendix.

of diseased gall bladders are associated with inflamed appendices.

The finding of carcinoma of the appendix at necropsy of tuberculous patients has been emphasized by several writers. Four of the patients with carcinoma of the appendix had latent tuberculosis. Bilateral tuberculosis of the fallopian tubes and peritoneum was found in 1 case.

CLINICAL DATA

Very little has been written on the symptoms and physical findings produced by tumors of the appendix, because they are similar to those seen in chronic appendicitis. McWilliams, in a review of 96 cases of carcinoma of the appendix stated that 83 per cent of the patients suffered from symptoms of appendicitis and that 28 per cent had symptoms for 1 year or more.

Léorat expressed the belief that attacks of pain in the right lower abdominal quadrant without fever, the tenderness persisting in the free intervals, is characteristic of tumors of the appendix.

In this series it was found that the chief complaint of 28 patients with carcinoma of the appendix was pain in the right lower abdominal quadrant. In the remaining cases, the pain was in reference to associated pathologic conditions. The chief complaints of patients with cystic appendices were as follows: pain in the right lower abdominal quadrant in 13 cases, pain in the epigastrium in 17 and pain over the gall bladder in 5. A history of carcinoma in the family was found in 9 cases, and of carcinoma of the appendix in 1 case. Among patients with cystic appendices, carcinoma had occurred in the families of 4 and tuberculosis, in 1.

Fever was not a prominent symptom of tumor of the appendix. The temperature did not rise in any case above 100 degrees F. Its onset was late in the attacks. The absence of fever in cases of tumor of the appendix, in comparison with its presence in appendicitis, has been mentioned as a differential diagnostic symptom. The low percentage, in cases of both neoplasms and of cysts, is significant. Nausea and vomiting were rather frequent symptoms, and occurred early in the attacks. Since early vomiting is a reflex symptom, due to distention of the appendix, it is reasonable that it should occur in cases of tumor of the appendix, especially in cases of cyst. It occurred in a higher percentage of cases of cyst than in cases of carcinoma, and was more persistent. This group of symptoms was absent in 45 of the cases of cystic appendix.

Pain referred to the epigastrium was the most frequent symptom of cystic appendix. Pain over the right iliac region in carcinoma of the appendix was rather infrequent, and it occurred in a low percentage of cases of cystic appendix. General abdominal cramps were complained of in a high percentage of cases of carcinoma, and constipation was more frequent than in cases of appendiceal cyst, probably due to adhesions being found more often in cases of carcinoma than in cases of cyst. Pain over the region of the gall bladder was associated more with cyst of the appendix than with carcinoma. The pain was of such severity as to require morphine in a higher percentage of cases of cyst than in cases of carcinoma. General abdominal tenderness, and also localized tenderness, were found more often in cases of carcinoma of the appendix than in cases of cyst. Rigidity, either local or general, was uncommon. Periapical infections of the teeth were relatively common in cases in which there was associated cystic appendix.

Estimations of hæmoglobin were made in 43 cases of carcinoma of the appendix. The average value for hæmoglobin was 76 per cent. The number of patients with a percentage of hæmoglobin of less than 70 was 7. In 49 of the cases with cystic appendix, the percentage of hæmoglobin was taken. The average reading was 70 per cent. The average number of erythrocytes in cases of carcinoma-

tous appendix was 5,018,000 in each cubic millimeter of blood. In cases of cyst, it was 4,365,000. The average number of leucocytes in each cubic millimeter of blood was as follows: carcinoma 10,800, cysts, 9,140.

Analysis of gastric content was made in 20 cases of carcinoma of the appendix. The average total acidity was 54 (end point in 10 cubic centimeters of gastric content produced by 5.4 cubic centimeters of tenth normal sodium hydroxide), the average free hydrochloric acid was 37. In cases of cyst, 24 analyses of gastric content were made. The average value for total acidity was 46.4, whereas the average value for free hydrochloric acid was 37.6.

Pre-operative diagnosis, then, is very difficult since there is nothing diagnostic, either clinically or in laboratory findings.

Questionnaires were sent to each of the patients. With the exception of those with pseudomyxomatous peritonei, no recurrence was reported.

SUMMARY

In a study of 45,000 appendices, 67 cases of carcinoma were found, the average age of the patient was 38 years, and 67 per cent of the cases occurred in females. One venous hæmangioma of the appendix was found. The presence of pseudomucin in cystic appendices, rather than mucin, was demonstrated by mucicarmine and safranin stains, and chemically by Hammarsten's reduction method. The absence of definite symptoms or laboratory evidence of tumors of the appendix is emphasized.

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THE STUDY OF THE EFFECTS OF ROENTGEN RAYS ON THE ESTRUAL CYCLE AND THE OVARIES OF THE WHITE RAT¹

DELLA G. DRIPS, M.D. ROCHESTER, MINNESOTA
Division of Medicine, The Mayo Clinic

FRANCES A. FORD M.D. ROCHESTER, MINNESOTA
Section on Therapeutic Radiology, The Mayo Clinic

THIS study was undertaken to determine two problems concerning which there has been much variation of opinion: (1) whether very light exposures to roentgen rays have any effect on the regularity of the estrual cycle and any degenerative effect on the cells in the ovary and (2) whether the estrual cycle can go on after all the so called ovarian structures, such as functioning follicles and corpora lutea, have been destroyed. Judging from the previous work of one of us on the cycle of the white rat after operative procedures on the ovaries, in no case did the cycle continue without ovarian structure being present although cycles were found to continue regularly without periodic rupture of the follicles and formation of corpora lutea.

The great variation in the histological effects on ovaries of irradiation with roentgen rays, reported by previous workers in this field, is probably the result of their using

different species of animals, animals of different ages varying exposure to the rays, and differences in individual susceptibility of animals of the same species and age. Geller found that not only the ovaries of animals in the same litter may reveal a different sensitivity to the rays but that each follicle in the ovary has its own sensitivity.

It is essential then that every worker in this field specify the kind and breed of animal used, the age of the animal at the time of the irradiation, the exact technique of the irradiation and the time elapsing between the last exposure and killing of the animal.

METHODS AND PHYSIOLOGICAL RESULTS

We have used only healthy animals of the usual laboratory strain. Litter mates were used largely in individual experiments. We were familiar with the usual onset of estrus and irregularities of the cycle in these animals from our previous studies; also we knew the



Fig 1 A, Normal ovary of an immature white rat B, Ovary of an immature rat 7 days after exposure to roentgen rays (574 r), cellular debris and remains of ova are in the follicular spaces

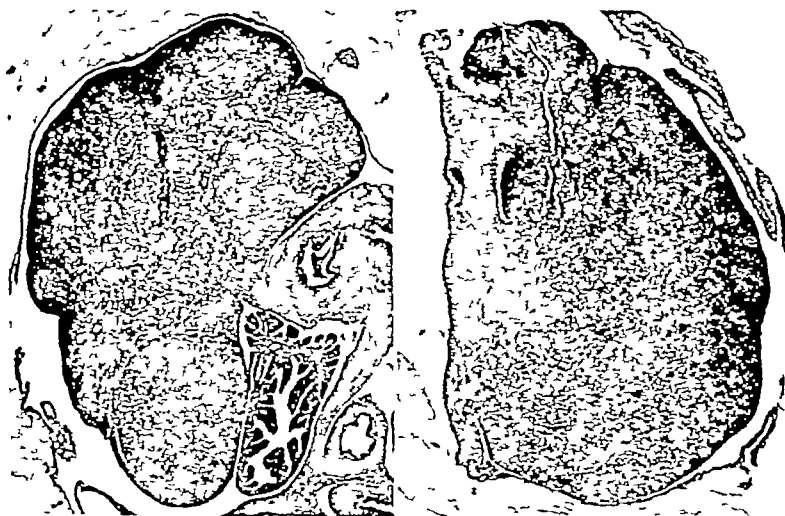


Fig 2 A, Ovary of adult rat 3 months and 16 days after irradiation (574 r), normal follicular structures are absent Corpora lutea are still present. Anovular follicles are present about the periphery B, Ovary of rat exposed to irradiation (574 r) at 5 weeks of age and killed 5 months and 24 days later No typical ovarian structures remain Anovular follicles are present, blood vessels are rather prominent

normal histology of the ovaries at various ages Rules relative to proper caging and food necessary for the maintenance of the normal cycle were observed

The occurrence of cycles was followed by taking daily vaginal smears At necropsy,

gross observations were made of the sexual organs, and the ovaries and a portion of the uterine cornua were preserved in Zenker's solution The sections were embedded in paraffin, cut serially, and stained in hæmatoxylin and eosin Every section of each series was

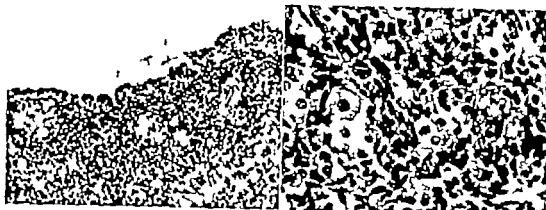


Fig. 3. A, Section through an ovary late after heavy dosage of roentgen rays. Hypertrophy of the germinal epithelium and anovular follicles are evident. B, Section through an ovary late after irradiation. The characteristic confused mixture of cells making up the greater portion of the ovary can be seen. Vacuoles and evidence of nuclear degeneration are present in many cells.

carefully studied to avoid missing any structure.

For the irradiation a Kelley Koett mechanically rectified apparatus, with a maximal capacity of 165 kilovolts, and a standard Coolidge broad focus tube were used. The voltage was measured by a standard sphere gap and r units at various settings were measured in air by a Victoreen dosimeter.

The exposure and method of application of rays varied as indicated in the description of the experiments. The animals were irradiated singly each was tied securely on an animal board and anesthetized throughout the irradiation to prevent movements which might alter the field of irradiation. We wished to avoid general irradiation of the entire body.



Fig. 4. A, Left ovary of rat irradiated (459 r) at 10 weeks of age and killed 4 months later. Hyperplastic follicular structure is evident. B, Ovary of adult rat irradiated (574 r) directly after laparotomy and killed 4 months later. There are three hyperplastic follicular structures; normal structures are not present.

Slight irradiation To determine the effect of very slight irradiation, 29 rats were given exposure of 15 seconds to 2 minutes through an abdominal field overlying the ovaries, the spark gap varying from 3.5 to 6 inches with no filter, a 5 milliamperere current, and a 9 inch skin focal distance. The object was to secure irradiation of approximately $1/15$ to $1/10$ human erythema dose at the level of the ovaries, corresponding to the low dosage of irradiation used in treatment of certain ovarian dysfunctions of human beings. The rats used had had regular estrual cycles for 6 weeks preceding the irradiation. In 14 of the 29 rats there was temporary irregularity of the estrual cycle immediately after irradiation. The most frequent alteration consisted of the skipping of one or two estrual periods, at times the stage of cornification which was present at the time of irradiation, and the subsequent interval, were prolonged.

Fifteen of these 29 rats were mated from 75 to 230 days after exposure to the roentgen rays. Eight of them were delivered of normal litters and 3 of these 8 were delivered of second litters which were normal. Two of the non-fertile rats were found at necropsy to have extensive pelvic inflammatory disease with pyocornua. Two others may have been too



Fig 5 Right ovary of same rat as that represented in Figure 4, A. The ovary consists almost entirely of one luteal structure. The cells stain like those of an early corpus luteum. Very little connective tissue is present. The structure appears hyperplastic although no mitotic figures are seen.

old to be fertile, although they were within the age limit which we had found in studies of

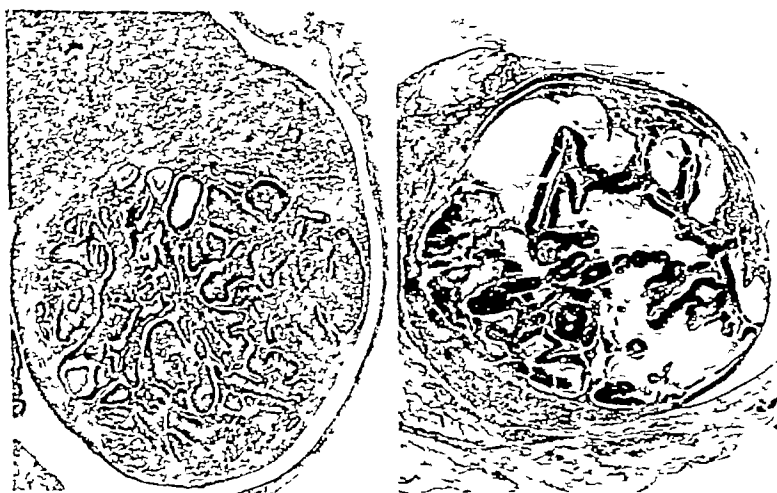


Fig 6 A, Hyperplastic follicular structure in ovary of rat 8 months after irradiation (574 r). B, Hyperplastic follicular structure in ovary of rat 6 months and 17 days after irradiation (574 r).

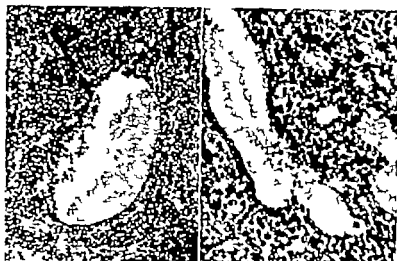


Fig. 7. A, Hyperplastic follicular structure in ovary of rat 8 months and 12 days after irradiation (574 r). B, Section of a hyperplastic follicular structure. Acinar arrangement of cells and the secretion are evident.

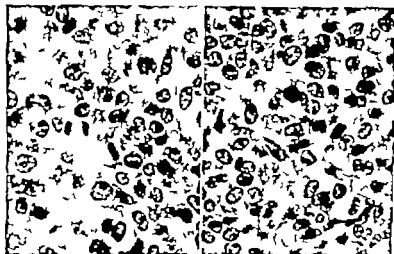


Fig. 8. A, Higher magnification of cells composing the hyperplastic follicular structure shown in Figure 7. B, The size of the nuclei and the mitotic figures are noteworthy. B, Higher magnification of cells composing the hyperplastic follicular structure shown in Figure 6, A.

normal rats for regular cycles and fertility. No explanation was found for the non fertility of 3 rats, which is a higher percentage than normal.

The 29 rats were killed at varying intervals after the irradiation. Aside from congestion noted in the ovaries of those killed within a

few days after the irradiation and the 2 with pelvic infection the ovaries of all were normal.

It seemed that the brief exposures to roentgen rays used in this experiment produced a temporary effect on the estrual cycle of about half of the rats. The only histological effect noted was congestion of the ovary. No

evidence was found of increased degenerative forms or of stimulated maturation of follicles, leading to earlier senility, which has been suggested as a possible mechanism to explain the effects produced clinically with analogous doses. In our experiments rays of greater wave length were used than are employed in treatment.

Irradiation of adult rats to produce sterilization of the ovaries. By sterilization we mean complete absence of functioning structures in the ovaries. We conducted many experiments, with varying exposures to roentgen rays, to determine the most efficient method of irradiating the ovaries of rats, the limit of tolerance of the rats to irradiation, and the irradiation necessary to produce sterility. In our early work, abdominal fields of a size necessary to cover the possible variation in position of the ovaries were used. On increasing the intensity of irradiation, some of the animals succumbed to toxæmia from associated intestinal changes. A dorsal field proved more satisfactory in causing less systemic reaction, and in securing more uniform effects on the two ovaries. However, even with the dorsal field, occasionally one pole of an ovary would be quite unaffected by irradiation, indicating that we were not always able to judge exactly the size or position of the field necessary to expose the ovaries, or that the animal had squirmed out of position in spite of all precautions taken to avoid this. It was found that with irradiation through a dorsal field (approximately 4 by 4 centimeters) and the use of a 6 inch spark gap, 1 millimeter of aluminum filter, a 9 inch skin target distance, 5 milliamperes of current, and 10 minutes' exposure (574 r at the surface of the skin) fertility was destroyed within a short period after irradiation. One rat, mated 8 days after the irradiation, became pregnant and was delivered of a normal litter, but subsequent matings were sterile. Structures were still present in the ovaries of these rats at the end of 3½ months, but the ovaries were completely sterilized by the end of 6 months. We could not follow the cycles carefully in these rats because of the matings but of those killed 6 months after irradiation only one was in estrus on the day of death and a hyper-

plastic follicular structure was present in one ovary of this rat. In all the others the uteri were very tiny and the ovaries so small they could scarcely be detected.

In contrast to these latter, 13 rats about 6 months of age were irradiated for 5 minutes (287 r), other factors remaining the same. In about half, as with all rats irradiated, there was immediate irregularity of the cycle. Other than this no effects were noted. All of this group became pregnant. One aborted and the others were delivered of healthy young. This result strongly suggested that in the rats that were given very light irradiation, the high percentage of sterility was to be explained by some factor other than irradiation. Three of these animals, killed at periods of 9 months, 14 months, and 14 months, respectively, after the irradiation, were still having cycles, and enough normal structures remained in the ovaries to arouse question as to whether there were any late effects attributable to the roentgen rays.

With exposures of 7½ minutes (420 r) there was an increased incidence of abortion when pregnancy occurred, and decreased fertility, although, in several instances, normal litters were produced. No malformations among the young were observed in any of the experiments. Temporary irregularities of the estrual cycle occurred in some of the rats after the heavier irradiation, as well as with the very light exposure mentioned. The limit of tolerance of this type of irradiation (dorsal field) seemed to be at about two times the sterilizing dose (1140 r), with the setting described.

Two healthy rats, 6 months of age, given this exposure, were critically ill following the treatment but eventually recovered. These 2 rats likewise had temporarily irregular periods. Thereafter, in 1 case, they became regular, then ceased 5 months after irradiation. In the other case, there were irregular, infrequent cycles for 3 months, then no further estrus was noted. Both rats were mated on several occasions without becoming pregnant, and both were killed 6 months after irradiation. At necropsy of both rats, the distal ends of the uterine cornua, oviducts, and ovaries were found matted together in the median line, and

adherent to the intestines and spleen. The uterus had undergone much atrophy and the ovaries were so tiny that they could hardly be detected grossly. Histologically they were found to be small, atrophic, and embedded in a mass of inflammatory tissue, a type that is described later.

Irradiation of young rats to produce sterilization of the ovaries. Irradiation with the assumed sterilizing dose was then applied to young rats in which the estrual cycles had not become regularly established. Two groups of rats were used—definitely immature rats and mature young rats in which the cycles had not become regular. In former studies, we had found that regularity of cycles is not established until the rat is about 4 months of age. There were 28 definitely immature rats, 9 of which were 5 weeks of age, 2 6 weeks of age and 1 3 months of age, the vagina of which was still closed. The 2 rats 6 weeks of age and the 1 3 months of age were given 10 minute exposures through a dorsal field with a spark gap of 6 inches, a current of 5 milliamperes, a 1 millimeter aluminum filter and a distance of 9 inches. With the setting described, 3 rats 5 weeks of age were given an exposure of 8 minutes, 7 of the same age and 6 that were 4 weeks of age were treated with an exposure of 7 minutes.

These 28 rats were killed at periods of from 4 hours to 16 months after irradiation. Seven were killed within a period of 4 months to allow study of the early effects of irradiation and will be mentioned with the following series. One rat died of the anesthetic. Twenty rats were kept for study of the estrual cycle and the late effects of irradiation. The vaginas of all of these opened and the first estrus was established within the normal time. One animal died 6 weeks after irradiation, having had only a few irregular cycles to the day of death; there was too much postmortem change present in the ovaries to make possible any decision about the effects of irradiation.

In 3 rats given the 10 minute irradiation regular cycles continued after maturity until about 4 months after the irradiation, and no more were observed before the rats were killed 8 months after irradiation. At necropsy the ovaries of these 3 rats were found to be

completely sterilized; typical structures were not present.

Thirteen rats given an exposure of 7 minutes had regular estrual periods for a much longer time—6 for at least 9 months, when observations were discontinued. These 6 rats were killed 11 months after the irradiation. Three of the 6 were in estrus on the day of death, and typical structures were still present in the ovaries. In 2 others, the uterus at necropsy gave no evidence of recent cyclic activity but structures were likewise still present. The sixth rat, in estrus on the day of death, at necropsy was found to have an enlarged and congested uterus but small ovaries. One of these ovaries contained several cysts, apparently follicular in origin, which were the only structures present, and no doubt were responsible for the estrus, for the other ovary was devoid of such structures. Follicle cysts and "blood cysts" have been noted by several observers, including Lacaze and Schims, following irradiation and as they have been associated with a continuance or reappearance of the estrual cycle in contrast to its disappearance in the other animals similarly irradiated, these structures have been held responsible for the estrus. We have found such structures, also, after operative trauma to the ovaries so they are perhaps not directly attributable to the roentgen rays. The seventh rat of the 13 had very irregular cycles for a time after the irradiation but later the cycles were completely regular to the ninth month. The vaginal smear of this rat on the day of necropsy 11 months after irradiation contained mucus and no follicular structures were present in either ovary. A few old corpora lutea were recognizable. This rat had been completely sterilized but the follicles had not been exhausted for 9 months. Two rats of the 13 had regular periods for 7 and 8 months, respectively when daily smears were discontinued. The rats did not come to necropsy.

The 4 remaining rats had fairly regular periods for about 6 months, when the intervals between the periods became greatly lengthened and at the end of 9 months we thought that the cycles had ceased and discontinued observations. These 4 rats were killed 15 and 16 months after irradiation. Smears of three of

the group made on the day of death were found to contain mucus, and the rats were found to have been sterilized. No typical structures were found in the ovaries, which were embedded in a mass of inflammatory tissue. The ovaries of 1 of the 3 rats were found to contain an atypical, hyperplastic, follicle-like structure. The fourth rat was in estrus on the day of death. No typical structures were present in the ovaries, but a hyperplastic follicle-like structure may have accounted for the estrus.

Three rats that were given exposures of 8 minutes matured and had regular cycles for 2 months, when each was given a second irradiation. These will be mentioned with another series.

In summary, the immature rats which received an exposure of 10 minutes, all of which were followed and subjected to necropsy, were completely sterilized. Cycles stopped at the end of 4 months after irradiation, when it is assumed the follicles became exhausted. Of the rats exposed for 7 minutes only, half were found sterilized at necropsy, the cycles continued for 9 months.

Twenty-two mature rats, less than 4 months of age, were next irradiated. Four rats 11 weeks of age were irradiated for 8 minutes through a dorsal field, with the constant setting of 6 inch spark gap, 5 milliamperes of current, 1 millimeter aluminum filter, and 9 inch distance. Twelve rats 3 months of age were irradiated for 10 minutes with these factors. Six rats, 2 months of age, in which the vagina had opened but in which cycles had not been noted, were irradiated with the same exposure and same technique. Only 4 of these 6 rats were observed for more than 4 months. These 4 rats ran irregular cycles for from 4 to 6 months and were killed at the end of 8 months, the ovaries of 1 were lost, 1 had been completely sterilized, the other 2 had not.

Seven definitely immature rats, mentioned earlier in this paper, and 18 rats of this group of 22 were killed within 4 months after the irradiation to study the early destructive effects of roentgen rays. Histological results will be summarized later. The ovaries of none of these animals killed within 4 months' time

were entirely devoid of functioning structures. The follicles of 1, killed on the forty-ninth day, were entirely gone, corpora lutea of varying ages, some apparently functioning, were present.

Repeated irradiations and direct exposure of the ovaries after laparotomy. Seven animals were given two exposures to the rays. Four had had an exposure of 5 minutes through the dorsal field, with the standard setting, and 205 r, or half the assumed sterilizing dose when 5 months of age. The cycles and fertility had not been affected. Six months later the ovaries were exposed by laparotomy and subjected to the full sterilizing dose. 6 inch spark gap, 5 milliamperes, 1 millimeter aluminum filter, 9 inch distance, and 10 minutes' time, protection was applied to all the body except the ovaries and ovarian pedicles. The rats were killed 4 months later. Three of these 4 had had very irregular cycles after the second irradiation. One had had regular cycles. None was mated. At necropsy, the ovaries of all 4 were completely devoid of functioning structures.

Three rats, not included in the 7 mentioned, the ovaries of which had been irradiated through a dorsal field for 8 minutes with the standard setting when only 5 weeks of age, and which had exhibited opening of the vagina and establishment of cycle within normal age limits and had been completely regular in cycles were submitted to further irradiation. When 3 months of age they were given a second irradiation to the ovaries only, after laparotomy, one and a half times the assumed sterilizing dose, or 15 minutes, was employed. The cycles continued, and the animals were mated, 1 became pregnant 4 months after irradiation, and delivered at term 7 fetuses, all of which were dead when discovered. A later mating was sterile although the cycles continued. This animal was killed 6 months after the second irradiation. The 2 others of the 3 animals were in the estrual state 6 months after the second irradiation, when they were killed. Enough structures were still recognizable microscopically in all these ovaries to account for the continuance of the cycles. These 3 animals illustrate better than any others of our series how resistant the ovaries of some animals can be to roentgen rays.

HISTOLOGY OF THE IRRADIATED OVARIES

Increased congestion was commonly found in the irradiated ovaries. In those exposed to very light dosage this seemed only transient. In those exposed to heavier irradiation, this congestion was at times very marked and persistent. Extravasation of blood into the tissues was noted several times.

Early effects The early effects of irradiation used (430 to 574 r at the body surface) were most easily noted in the ovaries of the immature or young rats, for these were made up largely of follicular structures and contained very few corpora lutea. Brambell, Parkes, and Fiedling found that 1 week after irradiation of mice 3 weeks of age, all the small oocytes had disappeared. At the end of 5 weeks, degeneration of follicles was complete. These workers employed repeated irradiation of the entire body (Fig. 1).

In our series, the youngest rats which survived the irradiation were 4 weeks of age. With our dosage we could not determine any definite effect of roentgen rays, other than hyperemia, before 3 days, and the degenerative effects were not marked before 7 days. At this time, it was found that the ova and the granulosa cells in the great majority of follicles had degenerated. This was especially true of the follicles of large and medium size. The theca of each follicle enclosed a space filled with cellular debris and the degenerated ovum. In these ovaries we found apparently undegenerated oocytes and small follicles with normal ova, although many were degenerated. There is normally marked physiological degeneration in the rat's ovaries shortly before maturity or before the first ovulation, and one must be familiar with this in estimating the effect of roentgen rays. In the normal ovary however there are always some mature follicles with healthy ova present. Degeneration of every follicle of large and of medium size such as we noted in several of the ovaries after irradiation, can scarcely be accounted for except as an effect of roentgen rays. The degeneration which followed irradiation was similar, in all respects, to the usual physiological degeneration. The result of this massive follicular atresia gave for a time, an appearance of an increased amount of interfollicular

cellular tissue. Many groups of cells became luteinized and thereafter seemed to degenerate, leaving spaces filled with pigment and cellular debris. In all the ovaries, from 1 week to 40 days after irradiation follicles of medium size, or mature normal follicles, were noted. Apparently some of the smallest and primary oocytes survived the irradiation and developed normally. The supply of follicles in the ovaries after irradiation, however sooner or later became exhausted and the ovaries were then entirely devoid of follicles. This complete absence of follicular structures was not noted in the ovaries we studied after the assumed sterilizing dose before 40 days after irradiation. The longest period after which normal follicles were found was about 6 months. In every case enough follicles were injured to exhaust the supply much earlier than in the normal rat. The corpora lutea were very resistant to the rays and persisted for a much longer period of time than under normal circumstances. Eventually they disappeared also so that the ovary might be entirely devoid of typical functioning structures. These ovaries will be further described later when late effects of roentgen rays are reported (Fig. 2).

Late effects of heavier irradiation of the ovaries Three types of ovaries were found late after application of roentgen rays. The first type was very small, containing no typical ovarian structures, but with numerous so called anovular follicles consisting of one layer of cells surrounding an empty cavity that lay close to the periphery of the ovary. These structures have been described, and their origin speculated on by Geller, Parkes, and others who have worked in this field (Fig. 3). They seem to be characteristic structures of the ovary after irradiation. The germinal epithelium may be intact and may not show hyperplastic changes or the cells may be piled up several layers deep or there may be a tufted arrangement of cells about a core of connective tissue. This is probably not specifically an effect of roentgen rays, for it occurs after trauma to the ovary. We have seen it to be a protective reaction and to occur most often in cases in which there was inflammatory reaction outside the ovary. This

apparent hyperplasia of the germinal epithelium occurred usually rather late after application of roentgen rays, and regardless of the age of the animal at the time of the irradiation. Mitosis was rare in the cells. In these ovaries there seemed to be a preponderance of fibrous tissue, surrounding the blood vessels and scattered all through the ovary. This was hyalinized, largely. In the meshes of this fibrous tissue were groups of many types of epithelial cells, characteristically ovarian, arranged in cords and whorls. Some of these cells were definitely pigmented, and resembled lutein cells. There was some deposit of pigment between the interstices of the connective tissue, probably the debris of degenerated lutein cells. The majority of the epithelial cells appeared to be like the characteristic interfollicular cells of the ovarian struma (Fig 4).

The second type of ovaries that was observed late after application of roentgen rays appeared grossly to be of almost normal size. Microscopically they contained very atypical, hyperplastic structures developed in a follicle. These atypical structures varied in size, apparently depending on the length of time after application of roentgen rays, the largest such structure was found in the ovary of an animal that had been given an intensive irradiation at 5 weeks of age, and that had been killed 16 months later. Each structure was surrounded by a capsule, apparently the same theca externa which surrounded the follicle, and in certain structures it appeared as if the theca interna were still present. The structures consisted of masses of epithelial cells assuming an acinar arrangement, with septums of connective tissue from the capsule extending into the interior, carrying blood vessels to every part. The cells which composed the septums were similar to those which extended into the center of an early corpus luteum, and no doubt the cells of the theca interna had been as active here as in the corpus luteum. Mitotic figures were present in the masses of epithelial cells which largely composed the structure. The epithelial cells about the acinar space seemed to have assumed a columnar shape, with the nucleus in the base of the cell, as in secreting cells, and

the space was filled with a secretion which resembled the liquor folliculi. It contained some cellular debris in places. Blood vessels were numerous in these structures. The structures resembled carcinomatous ovarian cystadenomata of the ovary of human beings. In some, hyperplasia of the follicular epithelium appeared to have been set up in a follicle that had been partially transformed into a corpus luteum. The masses of follicular cells about the periphery were crowding in toward the center between the cords of luteal cells (Fig 5).

In no instance did we see in a corpus luteum true evidence of hyperplasia, such as mitotic figures, although we found one very large corpus luteum consisting entirely of rather small cells, containing deeply staining cytoplasm and a dark nucleus, as in young, actively functioning glands. The rat from which this ovary was obtained had been irradiated (459 r units) at 11 weeks of age, and had been killed 8 months later (Figs 6 and 7).

The earliest time at which we have found such hyperplastic follicular structures was 4 months after irradiation. In the ovaries of 9 different rats, one or more of these structures was present in one or both ovaries. As far as we can determine, these structures have not been described previously. We are not certain that they can be attributed directly to the effect of irradiation. A number of animals the ovaries of which contained such a structure were killed while in estrus, although the cycle apparently had stopped completely some months before and its recurrence was an unanticipated finding.

The third type of ovaries that appeared late after application of roentgen rays was small, atrophic, and embedded in a mass of inflammatory tissue. This condition consisted of an apparent necrotic degeneration, with resulting formation of abscesses and inflammatory reaction in the tissues surrounding the ovaries. Small abscesses were found scattered through the tissues. Hemorrhage into the tissues was noted in some regions. Apparently the ovaries themselves were more resistant than the surrounding tissues, for an abscess was found in an ovary only once. The smallest ovaries were found in these inflam-

matory masses. In structure, they were like the atrophic ovaries already described. The periovarian spaces were obliterated, so that the ovaries were directly encompassed by the inflammatory tissue. The oviducts were dilated and were found filled with masses of leucocytes.

Grossly the inflammatory reaction was confined to the immediate vicinity of the ovary. Adhesions to surrounding structures were present in some (Fig. 8).

CONCLUSIONS

We have found great difficulty in securing uniform destruction of functioning ovarian structures with any one exposure to roentgen rays, due partly to individual variations in sensitivity of the follicles in different animals, and partly to technical difficulties of securing uniform irradiation limited to the ovarian field. A certain proportion of small follicles and primary oocytes apparently is uninjured even by the most intensive irradiation used (just within lethal limits) and during the time of their development cyclic activity of the uterus continues, although the animals are usually not fertile except for a brief period immediately after irradiation. The results of irradiation in our experiments confirm the fact that with complete atrophy of all functioning structures no cyclic activity occurs. This is apparently not in accordance with the findings of Parkes and of von Schubert both of whom have reported a continuation of the estrual

cycle after all of the follicular structures in the ovaries of mice have been destroyed by irradiation. A peculiar hyperplastic structure has been discovered in the ovaries of rats killed late after exposure to roentgen rays and in these rats a late return of the estrual cycle apparently occurs.

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AN APPRAISAL OF THE SURGICAL TREATMENT OF PULMONARY TUBERCULOSIS¹

HUGH H. TROUT, M.D., F.A.C.S., ROANOKE, VIRGINIA

DURING the past several years I have been greatly interested in the development of thoracic surgery, especially of those procedures which have to do with the treatment of pulmonary tuberculosis.

The reading of the early addresses of the past presidents of this association has given me some idea as to the scientific problems which confronted the founders of our association. At the time our association was organized abdominal surgery was then new and had only recently been made safer by the introduction of asepsis. Just as the founders of our society were confronted with the problems in abdominal surgery, we today are in a somewhat analogous position in relation to thoracic surgery, due to a better understanding of the physiology of the thoracic viscera, safer anaesthesia, "group thinking," improved X-ray technique, etc. It is my hope, therefore, that by discussing one of the problems of thoracic surgery, I may interest you in somewhat the same manner as my predecessors interested their membership. The subject I have selected is "An Appraisal of the Surgical Treatment of Pulmonary Tuberculosis."

In order that I may present the subject more accurately than would be possible from my own personal experience, I have visited many of the leading thoracic surgeons of this country, I have obtained information from 97 of the largest institutions for the treatment of pulmonary tuberculosis, and I have made a review of the literature. To those of you who are particularly interested in the literature, you will find the bibliography in Sauerbruch's *Chirurgie der Brustorgane*,² which brings the literature up to 1915. From 1915 to 1918 the bibliography can be found in Schroder and Blumenfeld's *Handbuch der Tuberkulose*.³ From 1918 to 1924, the bibliography can be found in Alexander's excellent book *The Surgery of Pulmonary Tuberculosis*.⁴

The bibliography from January 1, 1925, to January 1, 1932, will be published in the *Transactions of the Southern Surgical Association* for 1931. There are 1224 references.

Certain very elementary questions naturally arise when one considers even casually, this question of the surgical treatment of pulmonary tuberculosis. Perhaps, the most natural inquiry would be as to whether there is enough of this work to be done to justify a surgeon spending a year or more in preparation, since this newly developing specialty is far more than the "pulling out of phrenic nerves and the cutting of a few ribs" such as is now the all too general conception.

Who is to do this work? Where is this surgery to be done? Do the results thus far obtained justify a continuation of the efforts being made? These are the poignant questions.

There is no doubt in my mind that there is a sufficient number of patients having pulmonary tuberculosis, who are in need of surgical aid to justify, at least, the younger men who are members of this and other organizations, giving very serious consideration to the development of this part of their practice. For example, in the replies received from the 97 tuberculosis sanatoria, representing a bed capacity of 28,722, it is estimated that there are now in these institutions over 3,500 cases in which surgery (more extensive than artificial pneumothorax) is indicated. This estimation is made by those in charge of the sanatoria. Of course, this is only a small percentage of the number needing surgical aid, for it is impossible to approximate the total number of pulmonary tuberculosis patients in this country. Many such patients are not even receiving medical attention. It is estimated that only about 15 per cent of the known tuberculous patients do go to sanatoria. Such being the case, it is sufficient to prove to the unbiased mind that the need is urgent.

Until recently, the various operations for pulmonary compression have been more popu-

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lar in Scandinavia, Switzerland and Germany than in the United States. During the past few years, however, reports indicate a great relative increase of this work in our country. In the early Transactions of our association the discussion then centered on the question "who was to do the abdominal surgery—the general practitioner or a 'surgical specialist'?" Following this period there started a fight to limit the domains of surgery and of gynecology. As you well know it is only very recently that our association has dropped the name "gynecological."

Today somewhat similar questions are being raised. Shall the phthisiotherapist perfect himself to do these major surgical operations, or shall the general surgeon wake up to the importance of this subject and give it the very serious consideration that both the gravity of the work and the almost brilliant results demand? There have been some remarkable examples of internists developing into thoracic surgeons but, they are the exceptions. It is very generally the opinion of those now doing most of this work in this country that in the future such work should be done by surgeons having an excellent foundation in general surgery as well as a most intimate understanding of phthisiology and general medicine.

Much pioneer work has been and will continue to be done by members of the American Association for Thoracic Surgery but, it is very doubtful whether circumstances will permit of the development of this field as a few exclusive means of livelihood except in a few of our very large clinics. Eleven Fellows of our Association have membership in the American Association for Thoracic Surgery.

Most of our sanatoria are now in somewhat remote localities and few are sufficiently large to maintain a full time group of roentgenologists, surgeons, orthopedists, urologists, phthisiotherapists, etc., such as are necessary for the proper care of surgical cases. Therefore the patients must be transported to a general hospital where they can have the benefit of well trained operating room staff and receive even more careful postoperative attention than is necessary for the ordinary surgical case.

There are a few sanatoria in this country which are equipped to do surgical work in

their own institution. These institutions are located in or near a city where the services of any number of the group can be obtained at any time but, 83 of the 97 send their patients to a general hospital. The longest distance is 400 miles, and with 4 the distance is over 500 miles. Excluding these extremes and the 14 which have "surgical units" associated with their sanatoria in which all surgery is done, the average distance is 12 miles.

Of course perfect co-operation and teamwork between the phthisiotherapist and the surgeon is essential in managing thoracic cases before, as well as after the operation. The surgeon who does not have the aid of the phthisiotherapist in the postoperative handling of these cases will be as badly handicapped as the phthisiotherapist would be without the postoperative assistance of the surgeon. If one will only take the time to read the literature concerning the results of the surgical treatment of pulmonary tuberculosis, or to visit the sanatoria which have been convinced that the results of such surgery not only are justified, but demand the continuation of the effort.

It is interesting to note that during the past 6 years there have been more articles in the literature dealing with the surgical treatment of tuberculosis than there have been articles having to do with the medical and sanatorium treatment combined. This is probably due to the fact that the treatment in the sanatoria is somewhat standardized while surgical aid is in the process of development.

The phthisiologist decides in several months whether the patient can reasonably expect a cure by rest and such means, or whether he should be given the benefit of surgical aid. Certainly surgery should not be considered in any patient who is making satisfactory improvement under sanatorium treatment. Economic necessity for more rapid improvement, such as usually follows proper surgical aid is not sufficient justification for interference with an established improvement.

It is estimated that about 25 per cent of the patients admitted to sanatoria in the United States receive some form of surgical aid. In practically all this group of cases, artificial

pneumothorax is given first, and the results of such treatment are observed before more extensive surgery is attempted

The future may prove that excision of a lobe or lobes of the lung is the proper procedure, but, experience to now has demonstrated that lobectomy has no place in the surgical treatment of pulmonary tuberculosis

It is a well known hypothesis (but not sufficiently demonstrated to be accepted as a fact) that patients with cardiac obstructive lesions which tend to cause a venous passive hyperæmia of the pulmonary system, do not develop pulmonary tuberculosis. Some few men, accepting this unproved theory, have attempted to increase the venous hyperæmia of the lung by producing a partial obliteration of the pulmonary vein. The results of this type of operation have not been such as to justify its continuation

Ligation of the pulmonary artery has also been advocated on the basis of some experimental work which demonstrated that fibrosis of the lung followed ligation of the pulmonary artery. As yet, this operation has not been done on man

The sterilization of cavities by intravenous medication with mercurochrome, sanocrysin (thiosulphate of sodium and gold), cadmium (Walburn's method), etc., have been tried but with insufficient success to warrant the continuation of their use. Viosterol and vitamins B and D have been given orally in the hope of helping in the sterilization of cavities, but without any definite results. Also direct medication of the tuberculous lesions has been unsuccessfully tried. Recently a few deaths from introducing dyes and chemicals through the bronchoscope have been reported

At present the chief objective of all types of surgery for pulmonary tuberculosis is the production of a *pulmonary collapse*. Immobilization is the sheet anchor in the treatment of many cases of surgical tuberculosis found elsewhere than in the lung and therefore it is not surprising to find the same principle applied to the lung. In producing such a collapse it is necessary to give serious, careful consideration to the condition of the lung and the pleura

The object of the pulmonary collapse is to put the lung at rest either temporarily or

permanently. This collapse should be sufficient to help empty and obliterate any existing cavities. If temporary compression of the lung is desired, only those procedures which do not disturb the bony chest wall are employed. If it is necessary to put the lung at rest permanently, then it is essential to utilize methods which will not only collapse the lung, but will bring the bony frame in close contact with the compressed lung and prevent its re-expansion

The first attempt at the desired temporary pulmonary collapse is usually made by means of an artificial pneumothorax given by the phthisiotherapists. When these air "fills" were first being given, there were reported a few cases of air embolism. At the present time, the amount of air introduced is controlled by manometric readings and fluoroscopic observation. This is very essential in decreasing the danger of air embolism as well as the possibility of rupture of the lung by too much pressure where adhesions are present. The shifting of the mediastinum and pulmonary herniation require careful attention as regards the pressure. While the giving of these "fills" is very properly being done by the men in charge of the sanatoria, still the surgeon who does not follow what has been done to the patient before he receives him becomes simply an operative mechanic directed by the phthisiologists

It is interesting to note the extremes to which certain advocates of any relatively new procedure will go. Recently there appeared in literature a case report of artificial pneumothorax being given to a 5 month old baby. This is simply mentioned as a caution not to allow our enthusiasm to run away with our common sense. There is, however, no doubt that the correct diagnosis of pulmonary tuberculosis is being made at a much earlier age than was formerly possible. This is due to the efforts of a large number of roentgenologists who are particularly interested in this angle of their work and also to the recently improved X-ray equipment

It is generally agreed that at least 50 per cent of all artificial pneumothorax cases develop a small amount of effusion. Pleural effusions develop in a fairly large percentage

of cases which do not have artificial pneumothorax and these effusions are generally regarded as part of a defensive process. Aspiration of the fluid is indicated only if the toxic effects of the effusion be prolonged or if the amount causes either cardiac or respiratory embarrassment. Recently the intravenous use of calcium chloride has been tried for the prevention of these pleural effusions, but as yet a proper evaluation of the procedure cannot be given. It is certainly to the great credit of the phthisiotherapist that these effusions seldom become purulent.

Various oils, such as rape seed oil, olive oil, gomenol, etc. and different gases have been tried but, up to the present time, filtered air has proved the most satisfactory. Air is absorbed can be easily removed if necessary.

In the replies received from 97 sanatoria throughout this country it is interesting to note the difference of opinion existing in various localities regarding the percentage of those cases which demand more extensive surgery than artificial pneumothorax. This difference of opinion seems to be definitely related to the problem as to whether or not the phthisiologist and surgeon are working harmoniously. One phthisiologist out of this group stated he did not feel that any surgery not even artificial pneumothorax should be considered while another thought the situation was such that at least 75 per cent of the patients should have additional surgery. An average of the replies, excluding those extremes, would indicate that about 10 per cent to 15 per cent of the patients would be benefited by more extensive and properly applied surgery.

The success of the surgical treatment of pulmonary tuberculosis depends very largely on the proper selection of cases. Naturally as we know more about this subject, the scope of this type of work is increasing. For example, only a few years ago no surgeon ever thought of treating a bilateral lung involvement, but recently there have been some wonderful results with surgery in patients showing considerable involvement in the contralateral lung.

It has been very instructive and encouraging to see some few cases of tuberculosis of the larynx arrested and greatly improved in patients with a properly collapsed lung.

Even a larger percentage of patients having intestinal involvement have improved after having had the "feeder" of tubercle bacilli quieted by pulmonary collapse. For a number of years, the phthisiologists have generally considered it necessary to terminate early pregnancy in patients with pulmonary tuberculosis to prevent the greatly dreaded "flare up" which occurs usually during the nursing period and sometimes during the confinement.

If the pregnancy has gone to 5 or 6 months, the patients are allowed to go into labor because such is not any more taxing than the procedures necessary to terminate the pregnancy. During the past few years the involved lung has been held in a collapsed condition by an artificial pneumothorax, or if necessary by a temporary phrenic avulsion until after all danger incident to the pregnancy has passed.

I will not yield to the great temptation to enter the field of speculation concerning immunization, "auto-tubercullization," development of vaccines, prognostic value of blood changes in patients having had surgical aid, the decrease of the flow of toxin-laden lymph by lessening respiratory movement, production of fibrosis, the many and interesting observations which have been made on the change of circulation and character of the blood due to pulmonary compression or any other of the very enticing theories with which the literature abounds.

It is interesting to note, however, that the oxygen consumption remains practically the same after phrenic avulsion and closed pneumothorax. This is accomplished by increase of respiratory rate and labor and by a more efficient utilization of oxygen.

All thoracic surgeons are apparently in accord in considering patients over 55 years of age as unwarranted risks and all feel it highly important that the patient be of the type that produces fibrous tissue. This last factor can be best determined after several months of observation in a sanatorium.

If at this stage of the patient's progress, the X-ray and physical examination show that further collapse of the lung is prevented by adhesions, the natural question arises as to what is going to be done to release the adhesion. It is concerning the proper procedure to

be selected that there is now much controversy. It should not be forgotten that pleural adhesions are frequently a factor in the healing of a tuberculous process in the lung. Rest to the lung is sometimes obtained by the development of such extensive adhesions that the lung is firmly fixed to the chest wall and thus the excursions of respirations limited.

If it has been demonstrated by means of the X-rays and the thoracoscope that these adhesions are long, avascular string-like bands, then they can be cut safely with a cautery, in other words, a closed pneumolysis or the so-called Jacobaeus-Unverricht operation. Naturally, this type of operation has a somewhat limited field of application, for pleural adhesions are usually broad and wide and therefore do not lend themselves to safe severance with a cautery in a closed cavity. Recently the electrocoagulation of these adhesions has added to the ease and safety of this procedure. The proximity of the subclavian vessels makes this method dangerous with apical adhesions. A surgeon should never do an internal pneumolysis unless he has the operating room ready to meet an unexpected emergency. Of course, the artificial pneumothorax treatment is continued after the severance of these adhesions.

The instruments with which this procedure is accomplished are expensive and the use of them requires much special training, neither of which tends toward increasing the popularity of the method. However, there have been over 2,000 cases reported in the literature as having been treated by this method.

The other manner of attacking these adhesions is by opening the pleura near the site of the adhesion and directly cutting and tying these adhesions. This naturally has more of an appeal to the general surgeon, but the procedure has some very definite disadvantages. Apparently, the simple procedure of opening the pleural cavity frequently causes an effusion, and unless one's aseptic technique is perfect, an empyema will develop with all the train of symptoms and troubles commonly found with a mixed tuberculous fistula.

The percentage of cases developing effusions is about the same as occurs with the closed method, but, the chances of developing an external fistula are greater.

The closure of the pleural cavity without the leakage of air presents some difficulties which apparently are now being met by placing the incision so that the intercostal muscles can be sutured with the pleura.

One surgeon reports excellent results by doing a subperiosteal resection of a portion of a rib and then entering the pleural cavity through an incision made through the remaining periosteum. The periosteum then gives a firm structure in which to place sutures.

Recently producing an artificial pneumothorax on the side opposite to the adhesions has been tried. The object of this procedure is to displace the mediastinal structures in such a manner as to force the affected lung outward against the chest wall, thereby obtaining a temporary pulmonary compression. The few reports of this method have not been encouraging. The field of application of this procedure is necessarily greatly limited because of the frequent fixation of the mediastinum.

Operations on the phrenic nerve with the object of either temporarily or permanently paralyzing the diaphragm, are gaining more rapidly in popularity than any other of the surgical procedures employed in the treatment of pulmonary tuberculosis. When this method was first introduced, temporary paralysis of the diaphragm was the only procedure advocated, and then followed numerous reports of large numbers of phrenic nerves which had been either completely or partially removed. At present the tendency apparently is toward a saner and more reasonable situation, for now the phthisiologists and the surgeons are discussing how long they want the diaphragm to cease to function, or whether it is desirable to produce a permanent paralysis.

For example, a temporary paralysis of the diaphragm may be desired on the right side while an artificial pneumothorax, or some other type of operation, is being done on the left side in a case of bilateral involvement. With the return of function of the diaphragm on the right side, it might be advisable to reverse the procedure and produce a rise of the diaphragm on the left side with the further compression of the right lung by means of an artificial pneumothorax. Care should always be taken not to have an induced artificial

pneumothorax with a paralysis of the diaphragm, for in such an event, the air will force the paralyzed diaphragm downward and produce abdominal distress.

It is interesting to note the number of reports of cases in the literature in which a preliminary phrenic resection has been done with the view of doing a thoracoplasty later but, the patient's condition improved so markedly that the thoracoplasty became unnecessary.

The methods of producing a temporary paralysis of the diaphragm have been the results of much experimental work on the regeneration of nerves. The most generally accepted method is the simple crushing of the phrenic and its accessory nerve with a clamp as advocated by Yates. However alcohol injection and freezing with ethyl chloride still have some advocates.

There is much discussion as to the best method of permanently producing paralysis of the diaphragm and at present the most popular method is partial excision of the nerve. This is not without its dangers, and I want here to record a death which occurred with one of my patients as a result of such practice. This patient was in very bad condition and I removed about 12 to 15 centimeters of the nerve with but little pain. As the skin was being approximated, the patient's pulse became very weak and he died 6 days later with a hemorrhage in the mediastinum due to rupture of a vessel in the pericardium, which was evidently attached closely to the phrenic nerve in that locality.

While the finding of the phrenic nerve is usually a relatively simple procedure, it is not one to be undertaken by an inexperienced surgeon for such complications as injury to the thoracic duct and great vessels of the neck and thoracic duct have occurred and such misadventures have taxed the skill of even the best of surgeons. While the practice is not necessary still both the patient and the surgeon feel better to check the paralysis of the diaphragm by the use of the fluoroscope before the nerve is evulsed or resected.

The safer method certainly the one which makes a more logical appeal to a surgeon's instinct, is to resect a small portion of the phrenic nerve dissect down under the clavicle

find the necessary nerve where it leaves the brachial plexus to join the phrenic nerve and resect 3 centimeters of the accessory nerve.

When paralysis of the diaphragm was first introduced it was employed only to release adhesions and collapse cavities at the base of the lung but now we all see a surprising number of apical cavities closed by this means.

All pathologists and surgeons are apparently in accord in believing that some type of phrenic operation is the best method of checking pulmonary hemorrhage after artificial pneumothorax has failed.

To give proper consideration to the surgery of the phrenic nerve would require more time than an appraisal such as this permits, but we can all be certain that results of operations on the phrenic nerve have been such as to convert even the most pessimistic pathologist. One of the most instructive experiences a surgeon can have is to examine a series of roentgenograms of a chest in which the diaphragm has been paralyzed and note the steady and progressive rise of this muscle from week to week, and also to observe the clinical improvement of the patient.

In our experience the patients who had phrenic operations done on the left side have apparently improved more than those having apparently improved more than those having had the right-sided operations. This is due to several factors. The heart is frequently hindered in its motions by adhesions to the diaphragm. In 43 of our cases, the position of the heart was seen by roentgen ray films to be markedly improved after the paralysis of the left diaphragm. In all these cases both the pulse rate and volume improved after resection of the left phrenic nerve. This improvement must be attributed to the release of tension of the pericardial adhesions, since no improvement in the cardiac condition was noted prior to operation in spite of rest in bed, etc.

In this connection, it is interesting to recall that pathiotherapists find greater pressure can be withstood in the pleural cavity on the left than on the right side. The reason for this is that the right side of the heart being softer and having thinner walls than the left any pressure encroaching upon it is liable to disturb the filling of the heart with blood from the large veins.

Numerous operative procedures have been advocated to aid in the collapse of the apex of the lung, many most interesting, but, as yet, no one method has been devised to fit all cases.

Resection of a small portion of the three scalenus muscles has recently been advocated, and has the advantage of being done through the same incision in which the phrenic nerve is handled. In this manner, collapse of the lung is obtained by withdrawing the support of the scalenus muscles from the apex, and at the same time, with the use of the paralyzed diaphragm, the compression of the lung is increased from both top and bottom of the chest. This procedure is too recent to evaluate properly.

By resection of the intercostal nerves, Alexander has been able to produce a respiratory rest with the bulging inward of the intercostal muscles, thereby increasing the amount of active compression of the cavities. This is always done in association with paralysis of the diaphragm, and if the resection of the three scalenus muscles be added to these two procedures then the vast majority of the muscles entering into the function of respiration will have been put out of commission.

We will next consider those procedures, the final object of which is to place the bony chest wall over either a part of or the entire compressed lung.

For apical lesions, the periosteum has been dissected from the under surface of three or four upper ribs, displaced inward and then paraffin, fat, pectoral muscle, gauze or rubber drains, etc., placed in the cavity left between the displaced periosteum and the ribs. All these materials have been tried with varying degrees of success. None of them has been entirely discarded, though the procedure has been disappointing in most cases. It is interesting to recall that muscle is not prone to tuberculous invasion.

Recently Harvey has devised a most interesting procedure which gives promise of success, but this method also has its disadvantages. As yet, he has not published his report of his interesting experience, and it is with his permission I am allowed to describe briefly what he has done in a very limited number of cases. He places a dilatable bag in the space

between the displaced periosteum and the ribs from which the periosteum has been removed, fills the bag with water (or if he desires a roentgenogram, with sodium iodide solution). In this way, he is able to control the amount, and, to a certain extent, the direction of the compression.

When the roentgenograms show a sufficient amount of regeneration of bone in the region of the displaced periosteum, the bag is removed, and the ribs are resected so as to allow the skin, etc. to obliterate the cavity left by the withdrawal of the bag. Of course, the objection to all these substances which have been put under the ribs in order to obliterate the apex and to collapse a cavity, is that they are foreign bodies, and, as such, are liable to infection as well as to the probability of being expelled. In addition to this objection the "push" of these foreign bodies is downward and toward the mediastinum, and if the mediastinum is not well fixed by adhesions sufficient compression of the cavity cannot be obtained. It would be more advantageous were the compression directed downward and backward toward the bodies of the vertebra instead of downward and inward against the mediastinal structures.

Up to this point, we have discussed only those operations on the chest wall which have to do with a permanent collapse of *part* of the lung. If it is necessary to produce a permanent collapse of the *entire* lung then it is essential to consider some type of thoracoplasty.

The case of Dr. E. S. Welles illustrates the effectiveness of a properly performed thoracoplasty. The patient had had a thoracoplasty done 5 years previous to his death in an automobile accident. During these 5 years he was classified as a "complete clinical cure." The following is a partial report of the autopsy, which was kindly given me by Dr. Welles:

"Pleural cavity. On the left the third and fourth ribs are severed from the costal cartilages. The left side of the thorax is greatly contracted due to the previous resection of portions of the ribs posteriorly. The parietal and visceral pleura are almost completely fused on the left, and the left lung is collapsed and practically non-air-containing. There is a large triangular plaque of regenerated periosteum posteriorly near the vertebral column extending from the first to the tenth rib on the site of the thoracoplasty.

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geons remove the tip of the transverse process of the vertebra along with the rib. The vast majority of surgeons prefer the paravertebral operation. Sometimes the parasternal resections are preferable, but, usually, this procedure is employed to supplement a previous paravertebral thoracoplasty. Occasionally contralateral subperiosteal resections are advisable, usually as a supplementary procedure.

The decision as to where to compress the chest wall is largely determined by carefully taken and correctly interpreted roentgenograms. In other words, each case should be an individual study and the operation planned to fit the existing condition.

If the effusions in the pleural cavity are not contaminated by other organisms than the bacillus of tuberculosis, aspiration with replacement of air will usually suffice. If a mixed infection occurs, then a very grave situation is encountered. If the patient's clinical progress can be maintained by frequent aspirations and attempts at chemical sterilization of pleural cavity, such should be continued. If these methods are not successful, an extrapleural thoracoplasty should be done.

Occasionally an external tuberculous fistula develops, and in such cases careful attempts should be made partially to sterilize the pleural cavity before doing the thoracoplasty. It is possible that the filling of the tuberculous fistula with muscle as advocated by Pool and Garlock might prove to be the solution.

There is some discussion as to the advisability of these various procedures, but, there is certainly no doubt that open drainage should be avoided if possible.

After these deforming chest operations, it is important to keep the proper alignment of the spine, etc. by exercises, and sometimes braces are required.

Local anæsthesia is almost universally employed to the extent of the surgeon's ability to use it without pain or fear to the patient. If it is necessary or advisable to give the patient a general anæsthetic, either ethylene or nitrous oxide is usually employed. Both have ardent advocates and each has its disadvantages.

Avertin is not used because this rectal anæsthesia usually keeps the patient asleep for a few hours and thereby prevents the patient coughing up material which should not be retained in either lung. Ether is not usually given because of its irritating effect on the pulmonary tissue, though, in recent years, this has not been held to be as deleterious as was formerly thought. Spinal anæsthesia has been successfully tried in a few cases, but is generally considered too dangerous in thoracic work.

This appraisal of all the work that has been done on the surgical treatment of pulmonary tuberculosis is necessarily an incomplete report. However, I hope it is sufficient to stimulate an interest in a subject that so urgently needs our attention. If I have succeeded in doing this, I am more than amply repaid for the many miles of tiresome travel going from one clinic to the other, for the all too many hours I have spent with the literature, for the inconvenience I have caused 97 tuberculosis sanatoria in answering a questionnaire, and for any other effort that it was my privilege to make.

SUMMARY

There is a sufficient number of patients needing thoracic surgery to justify a general surgeon giving the subject the necessary attention.

The more extensive pulmonary surgery will continue to be done in general hospitals.

The results are good and promise to continue to improve.

An appraisal is given of the various operative procedures.

Today we are in a somewhat analogous position toward thoracic surgery that the surgeons of the early nineties were to the then new abdominal surgery.

Pulmonary surgery is designed to produce either a temporary or permanent collapse of the lung with subsequent healing by fibrosis.

No patient should be subjected to surgery if he is making satisfactory progress by medical or sanatorium methods.

This plaque has also been loosened from the adjoining ribs at several points. On the right the fourth rib has been severed at the costal cartilage. There is one long band-like adhesion on the lateral pleural surface about 4 centimeters from the apex. There is no hemorrhage in the pleural cavity.

Heart. Normal in size and exhibits a rather heavy deposit of fat. The aorta shows considerable thickening or atheromatous patches. The valves and coronary arteries are not remarkable.

Lungs. The left lung is collapsed and pressed close to the mediastinum. It is approximately 4 centimeters thick in its lateral dimension at the apex and slightly greater at the base. The anteroposterior dimension is only slightly less than normal.

A large mass of fatty tissue, 4 centimeters in thickness, lies between the apex of the left lung and the trachea and extends down the line of the costal cartilages to the fifth rib. On section the upper lobe of the left lung is atelectatic and markedly fibrous. There is evidence of an old tuberculous process in the well healed fibrous scars and thickened pleura in this lobe. The lower lobe of the left lung has been partially compressed, but is air-containing and shows marked emphysema at the borders. There are a few healed fibrous tubercles in the atelectatic superior portion of this lobe. The right lung is small but normal in appearance save for the adhesion previously mentioned and a few puckered areas near the apex. On section this lung is normal in appearance except for a small, beaded, fibrous scar at the apex and a cluster of small 2 millimeter calcified tubercles on the superior margin of the lower lobe.

Microscopic examination. *Left lung* presents all of the characteristics of artificially collapsed pulmonary tissue. Thickening of the normal connective tissue elements, dilatation of the capillaries and arterioles, dilatation of the peripneural lymphatics and infiltration with lymphoid cells. Apart from areas of disease there seems to be no thickening of the alveolar septa. Near the hilum is a rather extensive hemorrhage into the air spaces (traumatic?). The tuberculous process consists of well encapsulated foci of firm caseous matter.

There are many questions associated with thoracoplasties, any one of which would require more time to discuss than the limits of this paper allow. However there are a few points on which both surgeons and pathologists agree, and I will mention these very briefly.

Just the fact that 33 per cent of patients having had thoracoplastic operations are self sustaining 5 years after their operations and apparently in good health should be sufficient proof of the results, especially if one recalls that most, if not all, of these patients would have died in a few months if the thoracoplasty had not been performed. In addition to this,

another 33 per cent of patients are apparently improved in health but not self supporting. Of course, the mortality depends not only on the surgeon but on the type of case selected. There is one surgeon in America with an operative mortality of less than 2 per cent in a large series of cases. This speaks well for his manual dexterity and surgical skill, but, is also an eloquent illustration of what can be done by proper selection of cases.

The immediate mortality varies from 2 per cent to 8 per cent in the hands of the surgeons who are doing most of this work. In the hands of those surgeons with less operative experience and not as keen ability to select cases, the mortality goes as high as 30 per cent in the cases reported in the literature. However no case with even a reasonable hope of improvement should be refused operation because of the fear of "discredit to surgery" for every patient dying with pulmonary tuberculosis has a right to be given a chance for his life. If such a chance exists, regardless of statistics, these operations should always be preceded by paralysis of the diaphragm. They should be done in "stages" and the number of stages should be determined largely by the patient's general condition. The length of time between the stages can be indefinitely prolonged if necessary by the employment of Zenker's fluid to prevent regeneration of the periosteum. It must not be forgotten however that regeneration of some periosteum is necessary to produce and maintain a firm bony wall to prevent the lung from re-expanding. Most surgeons now prefer to resect the upper ribs at the first stage after having paralyzed the diaphragm. Frequently the clinical improvement is so great after these two procedures that the removal of the lower ribs is not necessary.

It is very essential to resect the first rib for this allows the entire hemithorax to drop downward since the first rib is the keystone. Alexander has, by dividing the serratus magnus muscle, procured a better exposure of the first rib. This muscle can be easily and successfully resected.

If the maximum amount of compression be obtained it is necessary to remove the ribs as close to the vertebrae as possible. Many sur-

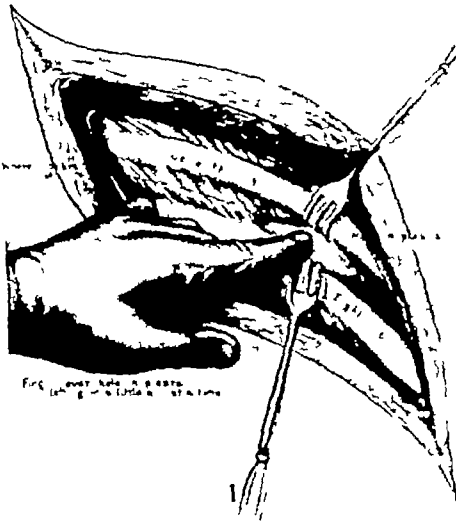


Fig 1 A long intercostal incision is made between the seventh and eighth ribs. This incision extends from the cartilages anteriorly to just beyond the rib angle. The dotted line shows where the ribs are severed posteriorly near the angle. Two or three ribs may be severed in order to give sufficient room for the procedure. A small nick has been made in the pleura over which the finger has been placed in order to permit the air to enter slowly and allow gradual collapse of the lung. If an artificial pneumothorax has been produced as a preliminary procedure, the pleura may be cut into boldly.

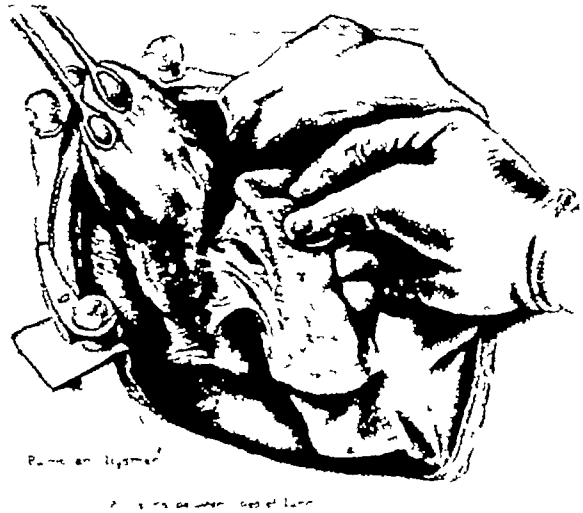


Fig 2 Lilienthal rib retractors have been inserted. The lower lobe is grasped with holding forceps. Adhesions are shown between the lower and upper lobes and the pulmonary ligament is well shown extending from the root of the lung toward the diaphragm. The mediastinum has been protected by a rubber dam.

many acute exacerbations, was frequently cyanotic and dyspnoeic, and has been hospitalized the most part of $4\frac{1}{2}$ years. The right middle lobe was removed with the intention of removing the left lower lobe at a future date but this will perhaps be impossible. It is questionable, therefore, whether this operation is advisable when the disease is advanced on both sides.

This makes in all 8 cases with 1 death. If we include the 13 cases of Dr. Shenstone we have 21 cases with 3 deaths.

Up to this time we have chosen patients whose condition was so serious that they gave every prospect of chronic invalidism for life and who did not respond in any marked degree or with any permanency to other forms of treatment. We believe, however, that these indications should be enlarged to include cases not so far advanced but whose ultimate progress would seem to be downward if the disease were left alone, and especially to include younger individuals in whom the disease involves but one lobe with perhaps only a beginning process on the other side.

It is fortunate in bronchiectasis that the patient can be brought into a fairly good condition of

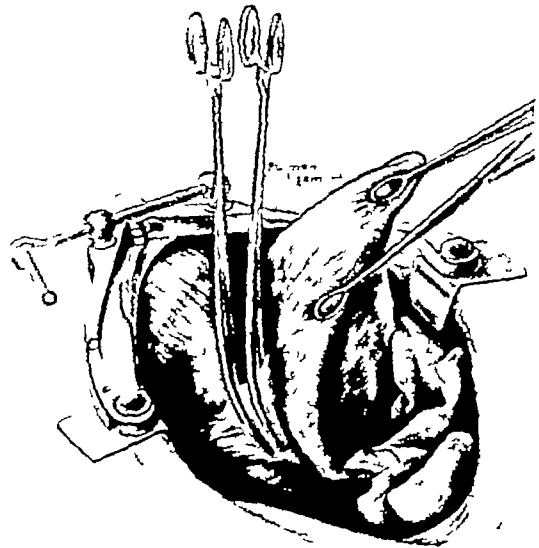


Fig 3 The adhesions have all been freed. The pulmonary ligament is clamped and tied in order to mobilize the pedicle of the lung.

CLINICAL SURGERY

FROM THE DEPARTMENT OF SURGERY UNIVERSITY OF CALIFORNIA

THE TECHNIQUE OF LOBECTOMY IN ONE STAGE

HAROLD BRUNN M.D. F.A.C.S., SAN FRANCISCO

Department of Surgery Division of Thoracic Surgery University of California Medical School

THE following technique for the removal of one or more lobes of the lung at one stage has been developed at the Thoracic Clinic of the University of California Hospital. We believe that it has many advantages.

The simplicity of the one stage operation is manifest. We believe that the fear of a high mortality has prevented surgeons from accepting this operation and that this fear is unjustified. The operation is simple, direct, and follows the usual principles of surgical procedures on other organs. It leaves the parts in their natural physiological condition and if the operation is carried out without technical error and the after treatment carefully supervised the ordinary case will pass through a convalescence not very different from that after any other surgical operation.

In a paper read before the American Association for Thoracic Surgery in 1928 the operation of one stage lobectomy was described with a report of several cases. It does not seem to have been adopted in American clinics as no further reports have emanated from them. However in a personal communication from Dr. Norman Shennstone of Toronto, on October 14, 1931 we find that he has with some modifications, which will be described later carried out this operation with considerable success. This confirmation of the operation in other hands has made it seem worth while again to review its technical details.

The greatest field for this operation is in bronchiectasis. It is one of the commoner pulmonary diseases. It may occur in many forms and with varying symptomatology. The use of lipiodol has brought to light many cases before undiagnosable. We do not of course recommend lobectomy for every case of bronchiectasis. There are many forms of treatment that must be tried and evaluated. However as pointed out in a recent very complete article on this subject by Drs. Ballou, Singer and Graham from the Washington University Clinic a cure can only be considered

when the diseased portion of the lung has been removed or destroyed. They have divided the treatment of this disease into two groups, non-operative and operative, and have described in detail eleven non-operative and ten operative methods of treatment.

It would seem that a well considered one stage lobectomy should find a prominent place among these procedures and we feel sure should supersede many of them.

Again quoting Dr. Shennstone who has kindly permitted me to use his statistics and whose paper will appear shortly in the *Canadian Medical Association Journal* we find that he has done thirteen one stage lobectomies for bronchiectasis, with two deaths, both of these on the fifth day from diffuse septic pneumonia. In three of these cases the middle lobe was also removed with the lower and in two a portion of the lingual process of the left upper

In the January 1930, *Archives of Surgery* we reported 8 cases of lobectomy with 1 death. In the fatal case the operation was carried out in a strange hospital and the after-care was not perfect. Since then we have purposefully carried out other methods of treatment for bronchiectasis awaiting the confirmation of our results in the hands of others. Thus we believe Dr. Shennstone has given us and since then we have begun another series of which there are but 3 cases. The first case (A. V.) has made a remarkable recovery. The second case (M. T.) was operated upon March 16, 1932. She is still running a high fever and her condition is extremely serious. Her recovery is doubtful. We feel that a poor choice was made in accepting this patient for operation but her condition seemed hopeless and, therefore for the first time, we undertook the operation on a patient with advanced disease on both sides. As will be seen by the X-ray plate (Fig. 13), there is extensive involvement in the right middle lobe and also in the left lower. This patient has had



Fig 5 The diseased lung is clamped several inches above the line of incision and the cautery is shown severing the pedicle in a wedge shaped-manner. The bronchus may be excised somewhat deeper than the vessels or it may be ligatured and cauterized, thus removing the mucous membrane from the interior

the number and extent of adhesions between the lung and the chest wall are discovered beforehand. It has been our experience that adhesions of any serious nature are seldom present in cases of bronchiectasis and I agree with Dr Shenstone in his statement that the fewer adhesions found in the chest simplifies the one stage operation. Third, artificial pneumothorax is supposed to diminish the shock which occurs when the chest is first opened on an uncollapsed lung. It is only fair to state, however, that before we adopted artificial pneumothorax as a preliminary procedure we made careful studies and in no case did we see any

change in pulse or respiration if the air was permitted to enter the chest gradually, allowing the lung to collapse slowly. However, the advantages of this procedure cannot be gainsaid and in our later cases we have adopted it.

Position on the table The patient is placed on the table with the affected side uppermost. The upper leg is flexed and a pillow placed between the knees with sandbags front and back. The head is slightly lowered in order to favor drainage from the affected lung and a suction apparatus is at hand to remove secretion and prevent spilling into the dependent lung.



Fig. 4. A rubber elastic tube is placed closely around the root of the lung and is pulled tight to control hemorrhage temporarily. First hemostat is then placed. Tension is again made on the tube and the second hemostat is placed and finally third. Removal of hemostats 1. and 2. releases the vessels gradually. In the lower picture fourth hemostat is placed above the ligature in order to prevent slipping which is especially liable to occur when the caldite lobe is removed alone. The field should be shown entirely covered with tapes and rubber dam. This is omitted to get better view of the field.

health by various preliminary procedures. The disease itself is frequently characterized by remissions and it is wise to wait for such an improvement. Rest in bed, postural drainage, bronchoscopes, sunlight the use of salivarium and thescodol as a treatment or other drugs injected into the bronchi along with transfusions make it possible in the great majority of cases to put these patients in such a condition that they will readily withstand a surgical procedure of this character.

Phrenicotomy As a preliminary to the operation of lobectomy the phrenic nerve is usually cut for two reasons. In the first place the movement of the diaphragm during the operation is quieted and if coughing supervenes shock is diminished

secondly following the operation, especially of the lower lobe, the space left in the chest is replaced by the elevation of the diaphragm. Where it is intended to remove a lobe on either side it is probably inadvisable to do a phrenicectomy as we do not wish to compromise the remaining lobes or cut down the vital capacity.

Artificial pneumothorax The production of artificial pneumothorax a few days or weeks prior to the major procedure has advantages. First, the secretions in the bronchiectatic cavities are expelled, thereby preventing spilling into the other side during the operation. This spilling may produce atelectasis in the other lung and frequently produces cough during the operation. Second

When the blood pressure is low or begins to fall during the operation we have used 50 to 75 milligrams of ephedrine. A tank of carbon dioxide and oxygen is at hand in case respirations become shallow or is used when the lung needs to be re-expanded in order to bring back the failing circulation. This is the best respiratory stimulant we have.

Dr. Shenstone uses spinal anaesthesia in his work by preference. We, however, have never had any experience with spinal anaesthesia in chest surgery and fear its effect on the blood pressure.

STEPS OF OPERATION

Incision. The incision is now made either between the seventh and eighth or between the sixth and seventh ribs and extends from the costal cartilages in front to just beyond the angle of the ribs behind. The intercostal space is exposed. Sharp claw retractors are used to spread the ribs apart at the interspace to be entered and the intercostal muscles are severed down to the pleura (Fig. 1). When artificial pneumothorax has been

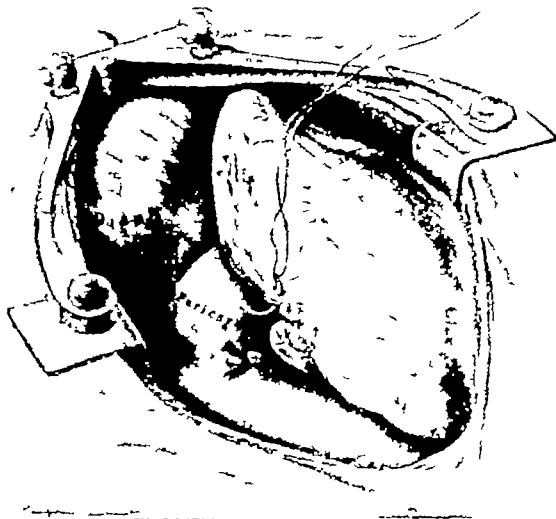


Fig. 7 The adjacent lung is tacked down over the pedicle.

produced the pleura can be opened boldly but when this has not been done a small nick is made in the pleura and the finger hastily covers it in order to allow the lung to collapse slowly and gradually. The interspace is then rapidly opened with scissors, traction being made on the ribs

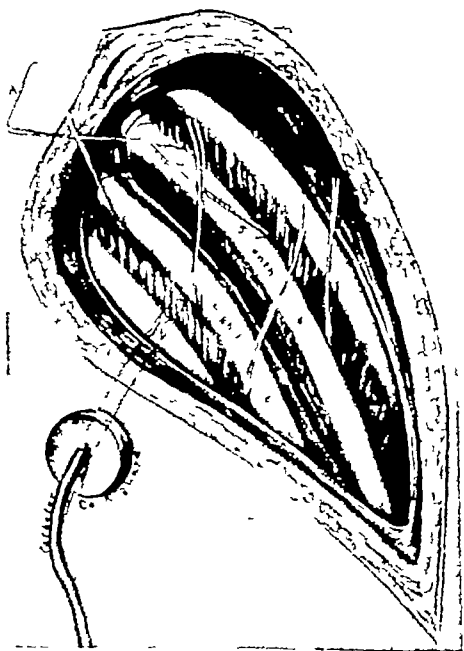
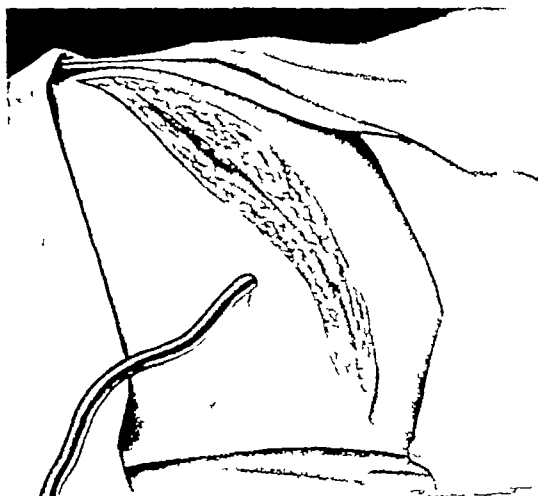


Fig. 8 A catheter has been placed in the chest through a stab wound or cannula a couple of ribs below the incision and a cork or rubber washer is placed over it to prevent entrance of air into the chest. Three double No. 2 chromic catgut sutures are thrown around the intercostal spaces above and below the incision and tied bringing the ribs together and closing the incision. The wound is closed in



layers with chromic catgut and through-and-through silk-worm gut in the skin.

Fig. 9 In the completed operation the wound was closed in layers without drainage. A closed rubber drainage tube or catheter is left in the chest and clamped after the air has been expelled from the pleural cavity by forced expansion of the lung by the anaesthetist.

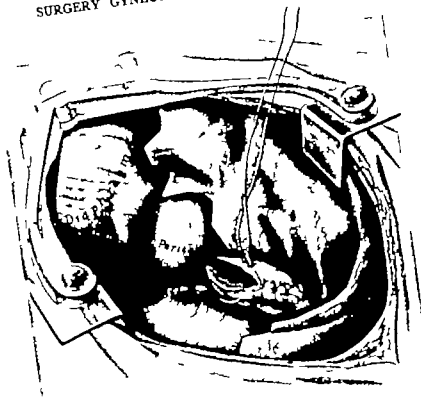


Fig. 6. Shows the method of closure of the lung pedicle. A running interlocking suture, one or two layers, is placed in the deeper parts. The first hemostat is removed when this stitch is finished and sometimes a second hemostat. If bleeding occurs the bleeding points are grasped and tied until all hemorrhage is controlled. A through-and-through suture is then placed, thus bringing the pleura well over the stump and closing off the bronchus entirely.

ANESTHESIA

A barbitol suppository of 15 grains (0.972 gram) or 10 grains (0.65 gram) by mouth is given 3 to 4 hours before operation. In our previous technique, scopolamine $1/300$ grain (0.3 milligram) and morphine $1/4$ or $1/6$ (16 or 11 milligrams) is administered hypodermically. One-half this dose or approximately $1/400$ grain of scopolamine (0.15 milligram) and $1/4$ grain of morphine (8 milligrams) is repeated one-half hour before operation. A syringe containing this same dose is at hand to be used if necessary during the procedure. This method has always given us a good anesthesia with local procaine but there are patients who vary in response to scopolamine and at present we have in avertin we believe a much more satisfactory anesthetic adjunct.

Preliminary to the use of avertin, $1/4$ grain of morphine is given one-half hour before operation to be followed by a rectal instillation of avertin 85 to 100 milligrams to the kilogram of body weight, depending upon the condition of the patient. Procaine hydrochloride $1/4$ per cent with a drop of epinephrine to the ounce is injected in rather large quantities along the intercostal nerves, both above and below the line of incision. In order to avoid shock it is very important that the patient does not cough during the operation. We have had no difficulty in keeping the patient perfectly quiet with avertin. With this anesthetic which is given in the patient's room, he lies comfortably asleep with very little if any drop in blood pressure and remains under its influence over a long period of time.

(Figs 10 and 11) This method, however, was somewhat cumbersome and did not allow the easy inversion of the stump. Latterly we have been using a temporary elastic ligature which controls the stump until hæmostasis is obtained. A small black rubber tube about 12 inches long is placed around the root of the lung and drawn sufficiently taut to produce compression of the vessels. The tube is clamped with a hæmostat (Fig 4). Again the tube is made taut and another hæmostat placed and finally a third. It may be advisable in certain cases to put a hæmostat just above the ligature on the opposite side (lower cut, Fig 4) in order to prevent slipping. This temporary ligature gives good control of the stump and makes easy the placing of stitches and ligatures. Clamps are now placed on the lung beyond to prevent soiling when the lung is excised. These are placed far enough away so that a wedge-shaped incision may be fashioned out of the stump, preferably with the actual cautery (Fig 5). This method of using three hæmostats gives perfect hæmostasis. When the first one is removed control is still obtained and gradual loosening of the pressure on the pedicle is permitted.

The bronchus may be cut out somewhat more deeply than the vessels or it may be ligatured leaving only enough projecting to prevent slipping of the ligature. The mucous membrane is cauterized. Both methods have been used. The vessels presenting are grasped one by one and separately tied, after which a running stitch of chromic gut with a lock suture is passed thus, closing the pedicle from the inside. This will usually control most of the bleeding. When this is finished (Fig 6) the first hæmostat is removed from the rubber tube and if no bleeding occurs a second one is removed. Any bleeding points are further tied until the stump is entirely dry. The pleura is inverted and covers over the raw surface with an interrupted or a running suture so that the stump is entirely closed. The under surface of the adjacent lobe is tacked to the stump with a few stitches (Fig 7). It is of the first importance that there be no hæmorrhage from the stump and no leakage of air from the bronchus into the pleural cavity.

Dr. Shenstone writes me that he has had some trouble with the clamp method and has devised another means of treating the pedicle which has been very satisfactory in his hands as can be appreciated from his statistics. He uses a snare threaded with a heavy cord with which he temporarily controls the blood supply of the pedicle. One snare is put on close to the mediastinum and a second one just above it to prevent escape of the

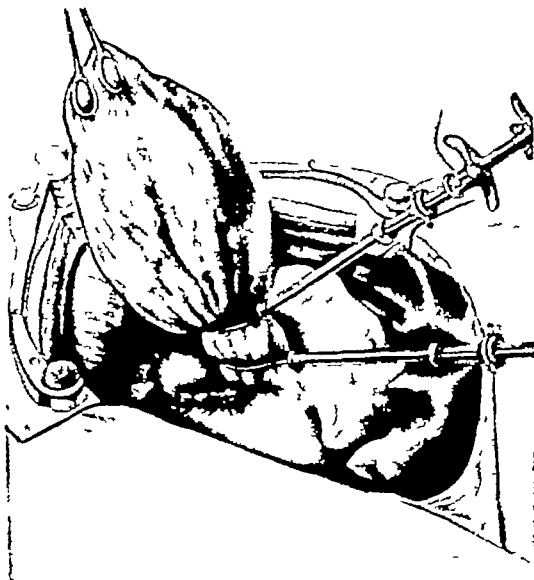


Fig 12 Method of handling the pedicle devised by Dr Norman Shenstone of Toronto, two snares threaded with a cord being used to encircle the pedicle

infected material during the section of the lung (Fig 12).

This method is quite similar to the rubber tube used by us, the only advantage in the latter being that no special instrument is required.

The field of operation is rapidly surveyed to see if there are any bleeding points from the cut adhesions and also to observe if the ligatures which may have been placed on the adjacent lung in cutting through the adhesions are in place. It is sometimes advantageous before closing the wound to have the anæsthetist expand the lung and then make another observation for bleeding points or for the escape of air from the alveoli. This survey is of extreme importance because in the after-care the leakage of air into the pleural cavity brings about collapse of the upper lobes and very materially delays convalescence. There is remarkably little contamination of the field during this operation and it is uncommon to have any infection of the wound in the chest wall following this procedure. Before the wound is closed a catheter or a small rubber drainage tube is inserted into the chest through a cannula a couple of interspaces below the incision. It is important to choose well the site that the tube shall enter and also that it shall enter the chest only a short distance.

Closure of the wound The chest wound is closed in the usual way. With a large curved needle

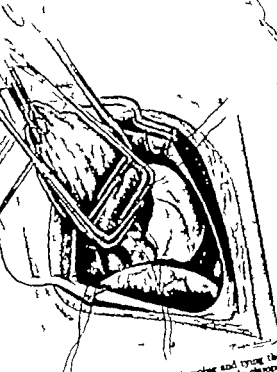


Fig. 1. The former method of clamping and tying the pedicle by the use of long Wertheim right angle clamps. Interrupted interlocking sutures are placed and re tied after the lower clamps have been removed.

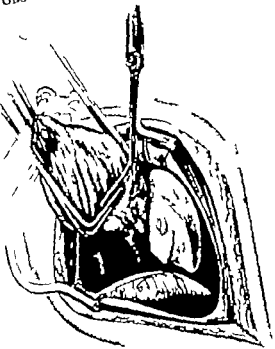


Fig. 2. The removal of the lobe with the cavity after the ligatures have been tied.

above and below with large blunt retractors. The space thus obtained is usually not sufficient except in the very young in whom the ribs are pliable and it is usually necessary in order to obtain sufficient room to cut the ribs with large bone forceps usually at their angle. One or two ribs above the incision may be so severed and if necessary one rib below. A Lillenthal rib spreader is then inserted over gauze pads and the entire chest cavity is exposed so that plenty of room may be had for the operative manipulation. It has been noted by us that early in the procedure the patient frequently becomes distressed. When this occurs we immediately remove the rib spreader, bring the chest back to its normal position, cover the wound with wet towels which are always at hand and have the lung slightly re-expanded with carbon dioxide and oxygen or nitrous oxide gas. The pulse and respiration rapidly become normal and when the operation is resumed it is seldom that the procedure has to be stopped a second time.

A survey of the chest is now made. The diseased lobe can at times be noted as somewhat contracted or having changed in color or it may be entirely normal on its surface so that one could not tell of the disease contained within it. The diseased lobe is grasped with lung forceps (Fig. 2). The upper lobe— if the lower is being removed—is allowed to collapse against the mediastinum and is covered with a large rubber sheet and moistened tapes. Adhesions between the upper or lower lobes and between the lower lobe and the diaphragm are now separated either by sharp dissection or between clamps and all bleeding points are carefully tied and the pulmonary ligament which is sometimes well developed as in the case depicted is now cut between forceps and tied (Fig. 3). The involved lobe is freed as far as possible toward the mediastinum and is held taut by an assistant. The entire wound and pleural cavity is now well walled off with rubber dam and moist tapes.

Management of the pedicle. Several methods may be used for the handling of the pedicle. We first used the large right angle Wertheim clamp



Fig 19



Fig 20



Fig 21

Fig 19 A V Lateral roentgenogram taken on same date as Figure 18

Fig 20 A V Lateral roentgenogram Lipiodol injection 3 months after operation for removal of the left lower

lobe All evidence of bronchiectasis of the left side has disappeared A closed bronchus where the pedicle was removed is noted at the root of the lung

Fig 21 Final result in A V

however, there is a secondary shock 3 to 4 hours later, and it is our custom at that time or earlier to use either glucose or salt solution or blood transfusions Suction on the tube reveals whether or not the shock may be due to hæmorrhage and if bleeding is continuous it may be necessary to re-operate

AFTER-CARE

Of equal importance with the operative detail is the after-care of the patient. There are certain underlying principles which must be constantly followed but naturally variations may be made to suit the particular patient. Special nursing day and night is required The closed tube which has been placed in the chest should be aspirated every couple of hours day and night to remove both the fluid which always collects in the pleural cavity following the operation, and also any air which may not have been expelled or which may leak from injured vesicles At first the fluid may be rather bloody but this should soon be followed by merely a bloody serum The object at this time is to bring about and maintain as rapidly as possible expansion of the upper lobes In some cases the collection of fluid is considerable for the first few days, in others it rapidly diminishes to a few cubic centimeters at each aspiration and in such cases the interval may be lengthened It is quite remarkable that in all the cases operated upon by

us the fluid which is removed has not been foul or infectious for a week or more No attempt is made the first 5 to 7 days to irrigate the chest. X-ray pictures are taken early and from time to time to make sure of the complete expansion of the upper lobes When this has occurred and when the drainage from the chest begins to be purulent, which, as stated, may not occur for a couple of weeks, Dakin's solution is used to irrigate with each aspiration The tube is allowed to remain until the suppuration clears up However, if there is a secondary rise in temperature which remains persistent, it becomes necessary to remove a rib in order to get better drainage as in any empyema cavity and the patient is then treated as an empyema case. Usually the cavity is small and rapidly closes

Bronchial fistula None of our cases have been troubled with a bronchial fistula If one forms it occurs after the stump has begun to slough and by that time the upper lobe has expanded and become adherent to the chest wall and the bronchus empties only into the small pocket We have never had to do any secondary operations for this It apparently takes care of itself I believe that the presence of a bronchial fistula is brought about—in the usual manner of doing lobectomies—by the gauze packing which is so commonly used Mediastinitis which is feared by many has

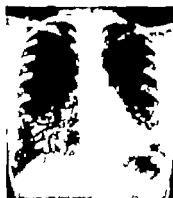


Fig. 13.



Fig. 14.



Fig. 5.

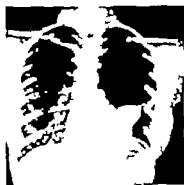


Fig. 15.

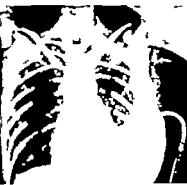


Fig. 7.

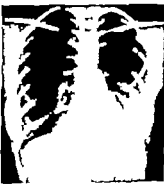


Fig. 8.

Fig. 3. M T X-ray plate after injection of Ipiodol. Large cavitations seen in the right middle lobe. It will be noted that the right lower lobe is entirely free. Also cavities incompletely filled in the left lower lobe. Other plates showed the upper lobes to be entirely free of cavitation.

Fig. 14. A V Anteroposterior roentgenogram after Ipiodol injection of both lower and middle lobes and part of the upper lobes. The left lower lobe is bronchiectatic. There is slight evidence of dilatation in the bronchus in the right lower lobe.

Fig. 5. A V Lateral roentgenogram shows marked

cavitation in the left lower lobe and small cylindrical enlargement of the right lower bronchus.

Fig. 16. A V Pneumothorax preliminary to operation with complete collapse of upper lobes. Small portion of lower lobe is seen projecting beyond heart shadow.

Fig. 7. A V Anteroposterior roentgenogram 5 days after operation shows the tube in place with the upper left lobe expanded. Chest practically free of fluid. Some thickening at the left base.

Fig. 8. A V Anteroposterior roentgenogram 27 days after operation. Left upper lobe is entirely expanded.

double chronic cutgut is inserted in the interspace above and below the incision. Three such sutures are usually placed and then tied, thus bringing the ribs closely together (Fig. 8). The muscles are closed in layers with No. 1 chromic cutgut and the skin with through-and-through silk worm gut. The wound is not drained and should be air tight (Fig. 9).

Finally the anesthetist either with nitrous oxide or carbon dioxide and oxygen expands the lung. The rubber drainage tube is placed in a basin of water and very slow expansion is brought about. The air from the chest bubbles out

through the tube until it is entirely expelled and the lungs completely expanded when the tube is clamped. We have now placed the lung in its natural physiological condition completely expanded with no foreign body except the tube in the chest. There is no packing and if there has been good hemorrhasis and no complications or mistakes made during the procedure we can feel reasonably assured that convalescence will be without event.

The patient usually leaves the table in good condition. After the chest is closed the pulse and respiration improve very materially. Frequently

FROM THE SURGICAL DEPARTMENT OF TEMPLE UNIVERSITY, PHILADELPHIA

THE OPERATIVE TREATMENT OF CARCINOMA OF THE RECTO-SIGMOID WITH METHODS FOR THE ELIMINATION OF COLOSTOMY

W WAYNE BABCOCK, M D, F A C S, PHILADELPHIA

FOR years surgeons have searched for an ideal method to extirpate cancer of the rectum and sigmoid. Gradually, from many methods and by work in many clinics, a fairly well standardized practice has been evolved. The necessity of a wide extirpation of the diseased bowel and adjacent tissues, and especially the regional lymphatics, as pointed out especially by Miles, has generally been accepted. The desirability of an abdominal incision to determine possible metastases, to remove completely the higher lymphatic structures, and to conserve properly the blood supply to the retained segment of bowel, is unquestioned. Thus the technique of the operation in recent years has crystallized toward an abdominoperineal operation in one or more stages in which the diseased segment of bowel and associated tissues are liberated from above, a colostomy done, a peritoneal diaphragm at the brim of the pelvis to wall off the pelvic cavity formed, and the diseased tissues finally removed, as a rule, from below.

To this conventional and generally accepted type of operation, the average patient has objections. First, he prefers a perineal anus and only by persuasion and education submits to a permanent abdominal colostomy. Second, he finds the obliteration of the large pelvic cavity a prolonged and at times distressing process. If a section of detached bowel is left in the pelvis between stages it is a source of infection and may render the second stage of the operation a fatal one. If a section of bowel is left permanently, distal to the colostomy, it tends to retain fecal or purulent material and give future annoyance. If an obstruction colostomy is used, the patient may pass into a dangerous condition of ileus before the loop of bowel is opened.

The surgeon also is beset by complications. The closure of the pelvic-peritoneal diaphragm may be difficult, so much so that the surgeon saves portions of peritoneum that in a radical operation should be removed. The pelvic diaphragm, moreover, is a fruitful source of postoperative danger. By the traction in closing the diaphragm, the lower ileum has been pulled down, angulated, and an intestinal obstruction produced. Several deaths have been reported from this cause.

Again, the thin peritoneal diaphragm in the post-operative period may yield to the pressure of overlying gas-distended coils of intestine. It is not strange that, at times, loops of bowel have pressed through the diaphragm, between the stitches and been strangulated, usually a fatal complication. In crushing the bowel preliminary to its division, bacteria are squeezed through the intestinal wall and may cause peritoneal contamination. If a culture is made from a sterile clamp after it has been used merely to crush the appendix, a growth of colon bacilli may be expected. Likewise, intestinal sutures often traverse Peyer's patches and carry bacteria into the peritoneal cavity.

Again, methods designed to facilitate the removal of the liberated portion of bowel through the perineum may jeopardize the patient's life. Years ago I devised a "pull through" method in which by an œsophageal bougie fastened to the bowel the mass was inverted and extracted. An œsophageal bougie of fairly large size was passed by an assistant through the anus and guided by the operator from the abdominal side through the cancer. Through the open abdominal incision, a heavy ligature was then tied about the bowel and shaft of the bougie just below the bulb. In some cases, the bougie could not be passed through the malignant stricture and therefore the ligature was tied below the carcinoma. By traction on the bougie from below, the liberated section of diseased bowel was then inverted and delivered through the dilated or split anal opening. Unfortunately, the rectal wall and particularly the malignant tissues are friable and under such traction or distention they often rupture with escape of septic material into the pelvic and abdominal cavities. A brief experience demonstrated that this operation was not a safe one and it was not published. Later, Coffey advocated a somewhat similar method of inversion, except that traction was made on a rectal tube fastened by suture to the upper end of the segment of bowel to be removed. This gave a less secure source of traction than the bougie and unfortunately offered the same difficulties and dangers. Under traction the ligature may tear out or the bowel rupture. In the delivery of the cancerous

never occurred in either my own or Dr. Shennstone's cases. Again I believe this complication is brought about by the use of gauze.

The factors which make for success in the one stage lobectomy are—careful preparation of the patient, careful after-care, hemostasis, and the prevention of pneumothorax or hemothorax for at least 5 days following the operation.

I feel that if we succeed in carrying out these measures satisfactorily the patient will go on to an immediate and satisfactory recovery and a short convalescence with neither fistula nor deformity occurring.

The following case (A.V.) is the one mentioned previously in this article as having been recently successfully operated upon.

This patient is a young girl 6 years of age. She gave long history of lung infections with continuous non-productive cough until she was 1 year of age. When she was 1 year old she was ill for 2 months with bronchopneumonia and at 2½ years of age suffered with whooping cough which was followed by continuous unproductive cough. She had influenza 1½ with an attack of measles and chicken pox following. At 2 years of age her cough, which had been constant for 10 years, became productive and foul, about one-half cupful of sputum daily. Tonsils and adenoids were removed at this time with an improvement in her condition. During the past 2 years the expectoration and foulness of her sputum had become much worse. She has, of course, always been below par and had to have extreme care at all times. The history is obviously one of severe bronchiectasis. Plaster and lipiodol plates were made. The anterior view shows large cavities in the lower left lobe with slight dilatation of the lower bronchial tree on the right side (Fig. 4). In the lateral plate (Fig. 15) this is shown to better advantage. This patient was kept under observation for a considerable period of time and under various forms of treatment—postural drainage, generous bronchoscopies and finally artificial pneumothorax all of which failed to bring about any substantial improvement so that operation was finally decided upon and accepted.

Artificial pneumothorax (Fig. 6) which was done as a form of treatment was continued and a preliminary pleurotomy was done September 3, 1931. The operation for lobectomy was undertaken November 7, 1931. It was this operation from which the artist Mr. Ralph Sweet drew the pictures in the text. Her convalescence was remarkably easy. The upper lobe on the left side expanded well.

On December 4, the seventh day (Fig. 7) following operation for the first time the fluid removed from the chest

wall was dark and thick like disintegrated blood and very foul. At this time Dulcis's solution was used every 10 hours alternating with salt solution. No coughing was produced by the Dulcis's solution so we felt the bronchus was not open.

On December 6, the temperature and pulse dropped, the cavity held about 15 cubic centimeters of fluid and the fluid removed was not so purulent. Blood count was red blood cells 3,300,000; white blood cells 7,500; hemoglobin 55 per cent; polymorphonuclears, 85 per cent.

On December 9, 3 days following operation, several pieces of necrotic tissue from the stump were obtained through the washings and the patient for the first time complained of salty taste in her mouth but had no further discomfort. A transfusion was given the following day of 150 cubic centimeters of whole blood to pick up the patient's general condition.

On December 13, the sixteenth day after operation, the patient was out of bed. There was very little cough, a small amount of sputum, and a decreasing amount of drainage from the chest. The tube was removed on the twentieth day and the patient left the hospital on the twenty-seventh day following operation (Fig. 8) practically cured with very little expectation, no temperature, and she looked quite normal. The wound healed per primam. It was not necessary in this case to remove ribs as there was no suppuration resulting from the operation. This patient has remained practically well up to the present time. She has had about 100 cubic centimeters of sputum in the morning and has gained about 10 pounds in weight.

Figure 10 shows lipiodol injection of the left side 3 months after operation. There is no indication of any bronchiectatic cavities. The left lower lobe has been entirely removed and the pedicle with a small enlarged bronchus is seen near the root of the lung.

NOTE.—At the time the article on "The Technique of Lobectomy in One Stage" was written the second case, M. T. was very ill as stated and since then died as a result of her operation while still in the hospital. This patient should probably not have been operated on for lobectomy as her condition was poor and the disease was far advanced on both sides.

On postoperative examination there was found a small draining empyema cavity where the lower right lobe had been removed. The upper right lung contained an abscess and was going on to necrosis almost gangrenous in some spots. The left lower lobe was adherent and contained numerous bronchiectatic cavities. The upper lobe contained small abscesses with frank purulent material. Therefore, as a result of the operation and the presence of large bronchiectatic cavities in the lower lobe of the opposite side the entire remaining lung became practically nonfunctional.

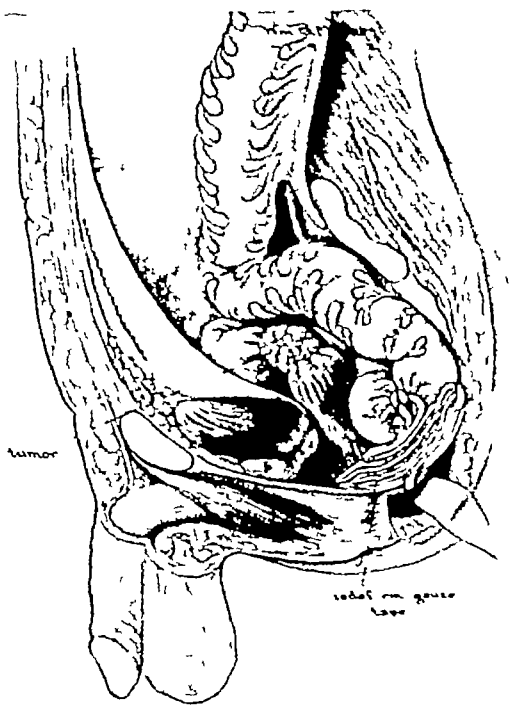


Fig 3 The abdominal part of the operation has been completed. The tape attached to the sigmoid has been packed against the floor of the pelvis, the separated bowel laid upon it, and the abdomen closed. Access for removal of the liberated structures is obtained through the perineum. By a median perineal incision the tape has been located for the withdrawal of the tumor and connected structures.

sacral or perineal anus has, we believe, been due to the technique and the poor viability of the bowel used. In many of the older operations, the end brought to the perineum sloughed for some distance into the pelvic cavity and left a cicatricial opening that was the source of much later trouble. By preserving the blood supply to the segment of sigmoid brought through the perineum, necrosis does not occur and an opening of ample size with little tendency toward a secondary stricture is readily formed. With an adequate opening, it is possible for the bowel to empty completely and the period between defecations is greatly lengthened so that instead of being constantly tormented by involuntary evacuations, as occurs with a strictured opening, the patient has intervals of 12 to 24 hours. As a rule, with a properly formed perineal opening, even though no sphincter has been retained, the patient has sufficient warning to avoid an accident and requires only the protection of a small pad. One of our pa-

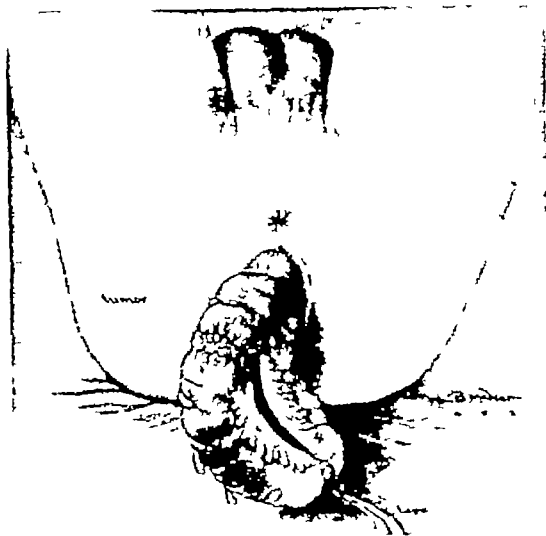


Fig 4 The tape with attached sigmoid has been withdrawn through the perineal incision and the cancer eased through the opening without traction.

tients with the rectum pulled through a thick flap from the buttock has never required a pad, a second goes for months without soiling the pad that she wears, others have retained a degree of sphincter control.

With modern clothing, the perineal colostomy is more conveniently taken care of than one upon the abdominal wall. While I have heard patients with an abdominal colostomy express regret that the opening was not in the perineum, none of the patients with this type of perineal colostomy has shown any desire to have the position of the opening changed. Often the perineal colostomy may be improved by a secondary operation designed to give better muscular or mechanical control.

Finally, the perineal colostomy is valuable in the 'follow up' for the determination of a local recurrence. Twice have we recognized a recurrent nodule by the finger in the perineal anus at a time when excision was feasible.

TECHNIQUE

The patient is prepared by a low residue, high carbohydrate diet, and by hydration in the usual manner for an intestinal resection. As the bowel will not be opened until after it has been delivered from the body, the wound closed and dressings applied, exhausting attempts to cleanse the colon are omitted. Moreover, as the bowel will be opened at the completion of the operation, a preliminary colostomy is superfluous for the milder

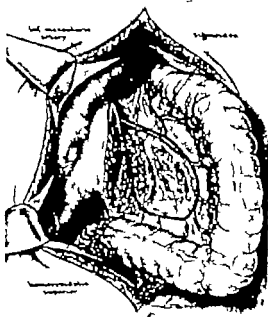


Fig. 1. The abdomen has been opened by lower paramedian incision. The outer leaf of the sigmoid has been divided. The inferior mesenteric and superior hemorrhoidal arteries have been exposed by an incision through the peritoneum and ligatures have been applied preliminary to their division. The circulation to the sigmoid is maintained as the ligation is above the critical angle.

loop we determined, therefore, that it was not safe to do inversion or to make traction through malignant tissue.

Without in the least compromising the radical features of the operation, we have modified the conventional abdominoperineal operation in four ways:

1. *The colostomy is eliminated* thus saving time and reducing the danger of peritoneal contamination. An immediate perineal anus is produced without clamping, division or suture of the bowel within the abdominal cavity. To avoid infection, the bowel is not opened or removed until all wounds are closed, and the perineal dressings in place. At the close of the operation, a rectal tube is tied in. Thus the dangers of an obstruction colostomy are avoided and, as a rule there is little secondary postoperative abdominal distention, the early passage of gas being facilitated.

2. *No pelvic diaphragm is formed*. By this omission time is saved, complications avoided, and the postoperative disability from the slow obliteration of the large pelvic cavity reduced.



Fig. 2. The sigmoid resection, attached mesenteric lymphatics, and fat have been freely liberated to the bottom of the pelvis. The mesosigmoid has been divided well above the carcinoma and wide gauze tape tied about the bowel. No attempt is made to cover this large denuded area.

Apparently the open and drained pelvic cavity although denuded, rarely causes intestinal obstruction. In over three hundred vaginal sections and vaginal hysterectomies in which large gauze packs were let into the pelvis through the open vagina no postoperative intestinal obstruction has been observed. In about thirty cases of proctosigmoidectomy with an open pelvis, postoperative meteorism has as a rule been slight. It is our impression that patients make better postoperative progress without the peritoneal diaphragm. Therefore we do not hesitate to do a very radical resection of the peritoneum with no attempt at peritonealization.

3. *A safe pull-through method is used*. The diseased bowel is brought through the pelvic floor but traction is made only through healthy intestine. A band of soft gauze about 2 inches wide is tied about the sigmoid well above the carcinoma. The ends of this gauze are packed against the pelvic floor where they may easily be located and withdrawn through a perineal incision after the abdomen has been closed. The gauze tie also indicates the site for the perineal anus.

4. *A perineal colostomy or anus is immediately formed*. The discredit which has attached to the

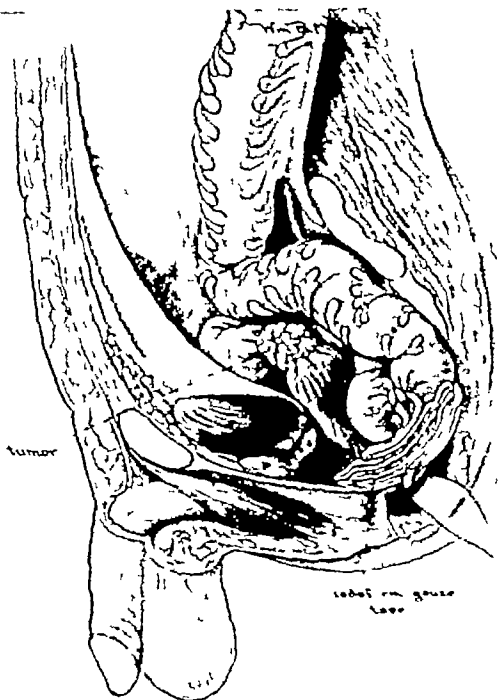


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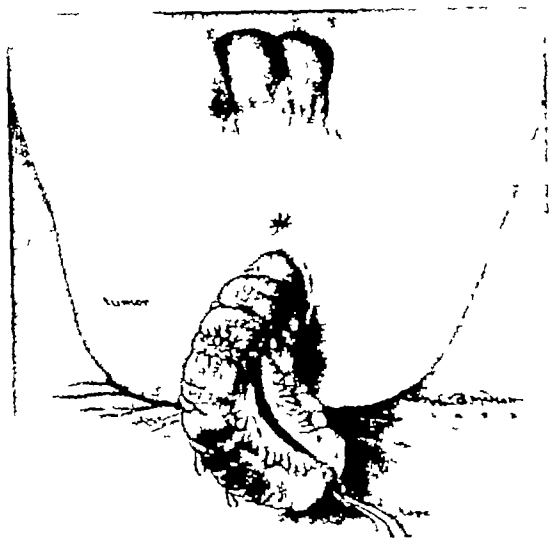


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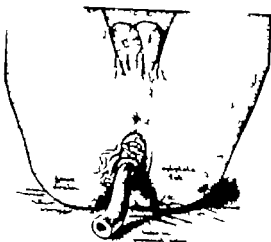


Fig. 5. A drain of iodoform gauze has been introduced into the right side of the pelvis. After application of aseptic gauze dressings to protect the wound from contamination, the withdrawn loop of bowel containing the carcinoma with the attached lymphatic structures has been amputated well beyond the gauze and large rectal tube tied into the proximal end of the sigmoid. For the sake of clearness, the final dressings applied before the loop of bowel is amputated are not shown in the illustration. For the lower rectal carcinomata, the anus and pelvic floor are freely excised.



Fig. 6. Pull through methods used in delivering the liberated bowel through the perineum. a, Coffey method traction being made upon rectal tube fastened by suture to the upper end of the divided bowel. b and c, Author's method, with the use of an esophageal bougie for traction. As the malignant tissue or bowel of less requires under traction with contamination of the wound, these methods are not advised.

forms of obstruction or those in which it is evident that peritoneal contamination has not occurred. For the acute and intense forms of obstruction where there is probability that virulent bacteria have already entered the peritoneal cavity a preliminary caecostomy or high colostomy should, of course, precede by 10 days or more the radical operation.

Much of the abdominal part of the resection follows conventional lines. Spinal anesthesia with an associated local infiltration of the abdominal wall with 150 to 200 cubic centimeters of epinephrin-procaine solution is the preferred anesthetic. The abdomen is opened through a lower vertical left transrectus incision. The lateral leaf of the mesosigmoid is freely divided well lateral to any malignant infiltration and the sigmoid with attached fat and mesosigmoid is mobilized by gauze dissection toward the midline. In doing this, the left ureter, iliac, and spermatic vessels are exposed. On the median side of the sigmoid just below the bifurcation of the aorta, the inferior mesenteric or the superior hemorrhoidal vessels are identified and divided between ligatures. At times, one or more of the sigmoid branches also require division to mobilize the sigmoid loop sufficiently but before dividing any questionable ves-

sel, it is first compressed to determine the effect on the blood supply of the sigmoid. The peritoneal incision is continued around the right brim of the pelvis and back of the bladder and the fat and lymphatic tissues stripped from the iliac vessels, ureters, and the hollow of the sacrum to the pelvic floor. The middle hemorrhoidal vessels may or may not require ligation. In separating the bladder it may be necessary to sacrifice the seminal vesicles. If in this separation, infiltrated tissue is encountered, the dissection from the abdominal side should be discontinued and the separation should be completed through the perineum. The matted tissues may cover a perforation through the cancerous mass or a focal abscess, the opening of which would contaminate the peritoneum.

The mobilization of the rectosigmoid having been completed, the mesosigmoid is divided well above the tumor. The middle of a strip of soft gauze so folded as to be 5 centimeters wide and 2 meters long is tied around the sigmoid at this level. The ends of the strip of gauze are firmly packed against the floor of the pelvis, the liberated bowel laid upon the gauze, and the abdomen immediately closed without drainage or any attempt to peritonealize the very large denuded area. This step of the operation may be completed without shock in from 20 to 45 minutes. The patient is now placed in the lithotomy position, and the

operation completed in one of several ways. In the simplest method, provided there is no involvement of the lower rectum or pelvic floor, the anus is closed by a strong pursestring suture, and covered by an aseptic gauze pad. An incision is made from a point just posterior to the anus to the side of the coccyx. This incision is deepened through the pelvic floor to the gauze packing which is grasped and withdrawn. By traction the attached loop of bowel is delivered through the perineum and, aided by retractors, the malignant section of bowel is eased through the opening, care being taken not to pull upon cancerous tissue. A portion of upper sigmoid with its mesentery now partially fills the pelvis and is permitted to rest against and adhere to the left pelvic wall. On the right side of the bowel an ample drain of iodoform gauze is introduced through the perineal opening. Gauze dressings moistened with compound tincture of benzoin are now applied around the base of the protruding bowel. The pursestring suture is removed from the anal opening. The loop of the bowel containing the cancer together with the attached fat and lymphatic tissue lying distal to the dressing is now removed by a knife or cautery, a large rectal tube passed for a distance of from 8 to 10 inches into the open proximal loop of sigmoid, secured by a ligature and additional occlusive dressings applied. This part of the operation may be done in 10 minutes or less and its simplicity renders it desirable if the patient is in poor condition.

Later the tissues between the sigmoid and anal openings may be divided and finally the keyhole-shaped anal opening may be corrected to restore sphincter control. A second and more satisfactory completion of the operation, if conditions permit, is to split the anal ring by an antero-posterior incision, dissect the anal mucosa from the sphincters, ligate the anal tube, and free the rectum through the pelvic floor. The rectum and sigmoid are pulled through the sphincters, a gauze drain is inserted, the incision partially closed by sutures, dressings are applied, the bowel cut away, and a rectal tube tied in. As the sphincters are retained, no further operation may be required except possibly the later removal of redundant protruding sigmoid. The sacrifice of the pelvic floor is, of course, important with the lower types of involvement. After the anus is occluded, a large ellipse of skin with underlying fat, muscles, the anus, and at times the posterior vaginal wall, or a part of the prostate and seminal vesicles, are liberated in one piece and withdrawn with the attached overlying sigmoid. The large opening is partially closed by suture, an ample

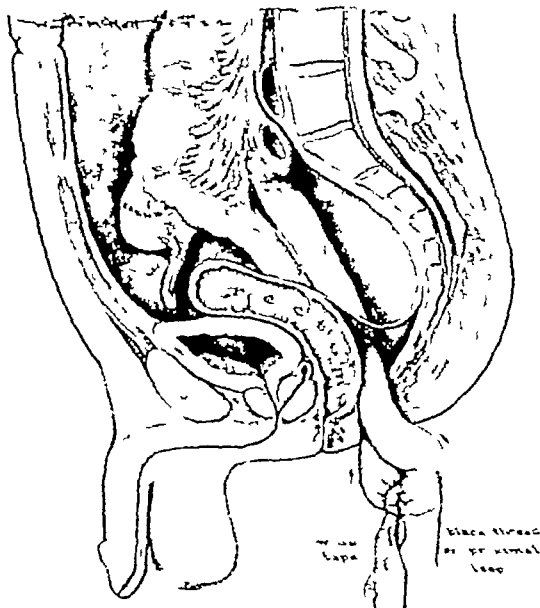


Fig. 7. Tape method for perineal ileostomy. Through an abdominal incision, gauze tape has been tied about a loop of lower ileum, the proximal portion of the loop being marked for identification by a black thread. The tape is packed against the pelvic floor, the abdomen is closed, and the loop is delivered through a perineal incision or through the anus. Ligation and division of the meso-ileum are unnecessary. Perineal ileostomy is a novel method for eliminating the colon and lower ileum in certain forms of carcinoma as well as in ulcerative and tuberculous colitis.

gauze drain is inserted to the right of the sigmoid, dressings are applied, and the liberated bowel and attached tissues are cut away and the rectal tube inserted.

Despite such extensive removal of tissue the patient usually has warning of an impending defecation. The operation is thus applicable to all types of removable cancer growing from the bowel below the level of the mid-sigmoid. Higher growths require a mobilization of the descending colon and perhaps the division of the colic artery, which may add undesirable complications. The method may also be used for the lower forms of diverticulitis.

In the after-treatment, a retention catheter is inserted for the first 3 or 4 days, drains are removed in from 4 to 6 days, and the patient is permitted to sit up the tenth day or later.

ADVANTAGES

Advantages of this operation are

1. The simplicity and rapidity of performance which enable a most radical abdominoperineal

resection to be completed in one stage without undue shock.

2. The ability to perform the operation without delay and without a preliminary colostomy in certain types of carcinoma with obstruction but without peritoneal contamination.

3. The elimination of the great sources of peritoneal infection during the operation.

4. The rapid closure of the pelvic cavity which may occur as early as the tenth or fourteenth day after operation.

5. A technical method is provided to avoid rupture of the cancerous bowel during the procedure of delivery.

6. A satisfactory and adequate perineal colostomy is formed.

DIAGNOSIS AND TREATMENT OF MALIGNANT TONSIL CONDITIONS¹

CURTIS T. BURNAM, M.D., F.A.C.S., BALTIMORE, MARYLAND

THE diagnosis and treatment of malignancies of the tonsil present problems quite similar to those of neoplasms of the posterior surface of the tongue, of the pharynx, and nasopharynx. The tumors are similar in histology, difficulty of diagnosis, clinical courses and general impossibility of adequate surgical treatment.

Fortunately, the disease is comparatively rare, nevertheless, the reported cases are, at present, rapidly increasing. The occurrence of uterine, cervix, and breast cancers is, at least, fifteen times as frequent as these tonsillar malignancies. Berven, 1931, reports 97 cases from the Radiumhemmet of Stockholm. Quick, 1926, reported 318 cases from the General Memorial Hospital in New York City. Schreiner, 1929, reported 60 cases from the State Institute for Malignant Diseases, of Buffalo. Coutard, 1930, reported 47 cases from the Curie Institute in Paris. The author has observed, since 1911, up to the present time, 165 cases at the Howard A. Kelly Hospital of Baltimore.

As with the other locations in the mouth, males are decidedly more frequently affected than females. In the series under consideration, 128 to 37 represents the relative occurrence.

The proportion of sarcomata is much greater in early life. The commonest age is after 40 for the carcinomata. Taking our entire material, in 139 cases the new-growth developed after 40 years of age. The age distribution in decennials is shown in Table I.

It has been impossible to estimate the influence of chronic infection as a cause. Syphilis does not seem to be a very important etiological factor, but is of importance as to prognosis and treatment.

In general, the progress of the disease is rapid. The occurrence of a tumor interfering with speech or with swallowing, or causing pain, would seem to make medical consultation at an early date very likely. In our series of 165, there was, nevertheless, already marked gland involvement in 116 cases—70.3 per cent. Many of these patients had been under medical care for several months. A positive Wassermann has in a number of cases led to anti-luetic treatment for a long period before a positive microscopical diagnosis has cleared the situation.

SYMPTOMS

The commonest initial symptom is pain which may be local but which more often radiates to the

ear, neck, and head. In a few instances, the appearance of a glandular mass in the neck was the first observed evidence of the disease. Hemorrhage has been rare as an initial symptom, but, of course, is common in the late stages. In the case of a few of the epitheliomata, discomfort on swallowing has been the initial symptom and has persisted for months before a visible lesion appeared. We have observed several patients who have been under the most expert medical supervision for this symptom where months have elapsed before a diagnosis could be made. In an individual past 40 years of age, a persistent discomfort and pain in the throat should arouse suspicion of a malignancy, such patient should not be allowed to escape frequent medical supervision until diagnosis is clear.

DIAGNOSIS

The diagnosis must rest ultimately on a microscopical examination, along with the clinical findings of the lesion, or a tumor. It frequently is possible, where there is ulceration, to do a biopsy from the primary lesion, or by the removal of a freely movable gland from the neck. Very nearly all of my own material has been classified on the basis of microscopical diagnosis, nevertheless, in a non-ulcerating, local lesion, or one with glands fixed and fused, it is probably, from patient's standpoint, wiser to be content with a clinical diagnosis. Protection against spreading the disease does not seem to be greater by removing the tissue with a cautery than by pinch forceps or knife.

In addition to malignant tumors, ulcerations, tumor formations, and glandular enlargements may be due to syphilis, tuberculosis, some of the ordinary chronic infections, and to Hodgkin's disease. Primary Hodgkin's disease of the tonsil is not uncommon, tuberculous infection is very common, syphilitic and trench mouth infections are also quite common. Therefore, it is evident that a most careful examination—not only of the mouth and neck—but, also, of the chest, abdomen, and blood is indispensable in every case. Along with the history, such examinations, not only establish the tumor diagnosis, but indicate its extent and probable character, prognosis, and most logical method of treatment.

TYPES OF MALIGNANCY

Secondary malignancy is rare in the tonsil. The author has observed 3 such cases, 2 of these were

¹Read before the Southern Surgical Association, White Sulphur Springs, West Virginia, December 10, 1931.

TABLE L—AGE DISTRIBUTION

Year	Women	Men	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	Received no inside	Temporarily cleared	Tumors and throat without glands	Tumors and throat with glands
1911														
1912		20				6	2					6		20
1913		3					3				3			3
1915	8	2									6	5		9
1917		8					6				3			7
1918	3										20		3	
1920		3				8						3	4	6
1921		10									3	7		20
1922		9									3	3		
1923	4												3	3
1924		20		2							4	3		8
1925		6												

adenocarcinoma from a primary breast and 1 from a very malignant embryonic type of adenocarcinoma of the testicle.

The primary tumors can be divided conveniently into the mixed tumors, the epitheliomata, and the sarcomata.

The mixed tumors are very similar in histology and in clinical course to the mixed tumors of the parotid gland. They usually are surrounded by a connective tissue capsule. The stroma is made up of mucoid, or cartilaginous, material containing fat and lymphoid material and epithelial cells, either in the form of glands or of stratified epithelium. They are firm but may present soft spots on palpation due to cystic degenerations. They may undergo malignant degeneration and invade surrounding tissues. In our series, not a single case of mixed tumor is included. Essentially benign, very good results have been obtained by operative removal. New 1925 reported operating on 10 of these patients, of whom 8 were living and well for periods longer than 2 years. Harmer and Russell, 1929, reported 7 cases, 4 of which were free of disease from 1 to 9 years. Beren 1931 in 5 cases, using radium and operation, has had 3 five year cures and 2 deaths. We have had one patient with this type of tumor which under X ray therapy was held stationary for several years and then began to grow very rapidly. Under intratumoral radon application it has shrunk to about one-fourth of its size. This patient has unquestionably a malignant and inoperable condition at present. Experiences with mixed tumors of the parotid indicate that these tumors are very ray resistant.

Epitheliomata The epitheliomata of the tonsil are the commonest of the malignant tumors. They are mostly of high grade histological malignancy. Broders classified 94 per cent of this material at the Mayo Clinic as belonging to either grade 3 or grade 4 malignancy. As I shall mention later ray sensitivity and high grade malignancy run parallel to a certain extent. Ewing, reviewing 200 cases, nevertheless, classifies 72 per cent as belonging to the ray resistant neoplasms. Costard, in 47 cases, places the percentage of ray resistance at 62 per cent. My own material has, as yet, not been sufficiently studied to give accurately the grading percentages, but I hope to do this in another paper at an early date.

Ewing very conveniently classifies these tumors into squamous, or spinous, cell epitheliomata, transitional cell epitheliomata, and lympho-epitheliomata.

The squamous cell epitheliomata vary in histological appearance from those composed of adult cells with a pronounced tendency to hyalinization and pearl formation to anaplastic growths which hardly can be distinguished from sarcomata. The appearance is well shown in Figures 1 and 2.

Transitional cell epitheliomata are made up of sheets of large, pale, delicate cells with large nuclei and indefinite outlines. These cells show no tendency to keratinization or pearl formation. My first experience with these tumors was in the nasopharynx. These cases were reported by Crowe and Baylor in 1923. This type of tumor is shown in Figure 3.

Schminke and Regaud independently of each other reported the so called lympho-epitheliomata



Fig 1 Low power photomicrograph of a typical epidermoid epithelioma

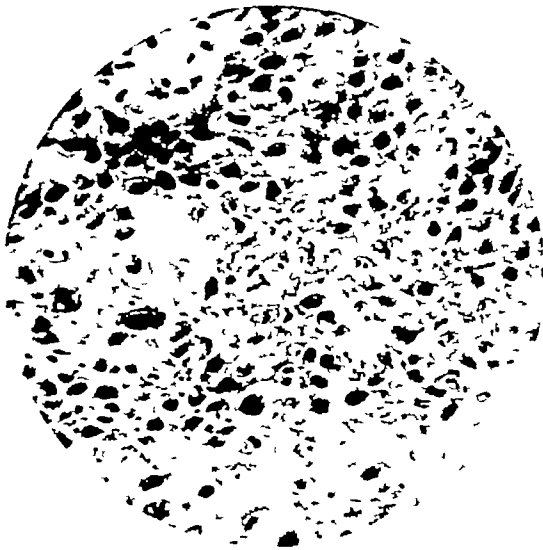


Fig 2 High power photomicrograph of same section as in Figure 1

in 1921. These tumors, which are common in the nasopharynx, the pharynx, the posterior portion of the tongue, also are common in the tonsil. They are, histologically, very similar to the transitional epithelioma, but include rapidly proliferating lymphoid tissue which gives the same histological impression as lymphosarcoma. A section of this tumor is shown in Figure 4.

Sarcomata The sarcomata of the tonsil are principally lympho-sarcomata. They may be limited to the tonsil or be present there and in other parts of the body. Fascial, spindle cell, fibrous, large round cell sarcomata are quite rare. We have observed none of them in our series of cases. The appearance of lymphosarcoma is shown in Figure 5.

GENERAL SURVEY OF RESULTS OF TREATMENT

Since Matthews' report, 1912, of the surgical results obtained in treating malignant tumors of the tonsil, there are no satisfactory reports of extensive series of cases from a single clinic, although there are numerous individual cases reported in the literature.

The radiological treatment, however, is fairly well recorded. Schreiner reported 60 cases treated between 1915 and 1925, of which only 2 were living, one for 4 years and one for 3 years. Quick, between 1918 and 1928, reported 318 cases, of which 28 were living for more than 3 years. His percentage of 3 year cures is 8.7 per cent. Coutard reported in 47 cases a 7.7 per cent cure in

epidermoid epitheliomata and 62 per cent in other cases. New reports of cautery and radium treatment of the tonsil and block dissection of the neck in 15 grade 1 epitheliomata, 4 of whom were living from periods of from 1 to 6 years. Berven states that he has had 28 cases of epithelioma of the tonsil treated by surface applications of radium and external X-raying, that none of these patients remained well for longer than 18 months, that he has treated 14 cases by surface radium and intratumoral radium, combined with telradium, and has had 3 year cures in 4 patients, or 28.6 per cent. There are practically no 5 year cure rates recorded in the literature.

Our own cases date back from 1911. Up to 1915, the treatment was by surface radiation alone. While definite effects were obtained on the tumor, the reactions were so disagreeable and the results so unsatisfactory that we felt the treatment of very little value. Beginning about 1915, we started telradium and implantation of bare radon tubes. Some years later, the bare tubes were replaced by gold covered tubes. Of 123 cases treated between January, 1911, and January, 1927, there are 12 cases living and apparently well—a percentage of 9.75 per cent. Of the total of 165 cases, 88 have shown primary healing of the local lesion in the mouth. Only 33, however, remained well for periods longer than a year. These 33 cases are selected out of the entire group and represent 20 per cent of cures. A good many cases have been lost sight of and we have been unable to



Fig. 3. Typical latentiated cell epithelioma. Very high grade of malignancy.

trace them. All of these patients have been marked in our tabulations as dead from the disease. Considering the permanency of results, out of a group of 47 cases, in which there was primary clearing up of the disease and in which we have indisputable microscopic evidence of the character of the trouble, there were 31 epitheliomata and 16 sarcomata treated prior to 1926. Eight of the sarcomata, or 50 per cent, remained well and 4 of the epitheliomata. This gives a 5 year cure rate of 12.9 per cent.

Taking into account all of the malignant tonsil cases treated prior to 1927 there were 95 cases in which either epithelioma was diagnosed clinically or by microscopical study. Many of these patients had immense involvement of the neck and of the mouth; many were treated only once; many have been lost sight of but taking this whole material the cure rate has been 4.12 per cent.

Taking the entire sarcoma group a very large number of which had general metastases at the time of treatment, and in which the diagnosis frequently was made on clinical findings alone the cure rate has been over 20 per cent.

We feel that our technical methods are being improved. Of 10 cases treated in 1929 and 1930, in which we have definite diagnoses of epithelioma, 5, or 50 per cent, are at the present time entirely clear of all evidence of the disease.

Of our 4 cases of cured epithelioma of the tonsil which have lasted for more than 5 years, 3 were

without demonstrable gland involvement. Nearly all of the sarcomata had gland involvement at the time of treatment.

TREATMENT

Before considering the technical details of treatment, it is important to review some of the facts and principles upon which ray therapy is based. The cure of a malignant condition by radiation fundamentally is based on the conception that malignant tumors can be destroyed by doses of rays which will not destroy or seriously injure normal surrounding tissues and structures. Both normal structures and malignant tumors vary greatly in their capacity to tolerate radiation. Some growths can be destroyed by radiation in quantities only about 1/30 of the amount known to be necessary to produce an erythema of the normal skin. On the other end of the scale, there are growths which will tolerate from 4 to 5 erythema skin doses. The essential reason for these variations is not known. It has been determined, however, that the microscopical architecture has an important bearing in estimating the probable effects of radiation. Tumors approaching adult, normal tissues are, for the most part, ray resistant. Tumors which are composed of undifferentiated embryonic like cells are ray sensitive. The most sensitive of the tumors with which this paper has to deal are the lymphosarcomata. The next are the lympho-epitheliomata and, in order the transitional and squamous cell epitheliomata. In an individual type, there are marked variations between the different tumors. Occasionally a lymphosarcoma is very ray resistant and, very rarely a squamous cell epithelioma will respond beautifully to a single erythema dose. Compared to uterine cervix, the tonsil is surrounded by normal tissues which, of themselves, are very ray sensitive and the injury of which may lead to pain, disturbance of nutrition, and many disagreeable symptoms. The mucous membranes of the mouth are more ray sensitive than the skin. The salivary glands are injured easily. There are many important nerves and blood vessels in this region. The perosteum of the hard palate and, more particularly the mandible are very ray sensitive. It is possible, by too heavy cross firing, to destroy easily large parts of the mandible. It is this fact that has made radiation of epithelioma of the floor of the mouth and gums so difficult. The results of treatment, as with malignancy everywhere, are dependent on the extent of the involvement. Immensely extensive neck and throat infiltrations may make it utterly impossible to carry out an effectual ray damage throughout a tumor.

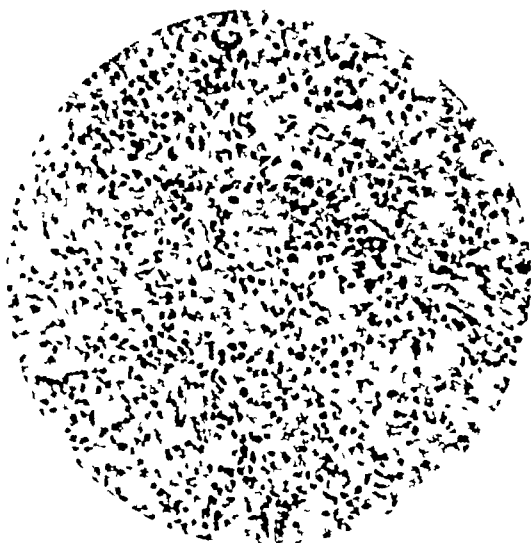


Fig 4. Lympho-epithelioma



Fig 5 Lymphosarcoma.

Ray therapy has its technical limitations as definitely as surgery

It does not seem to be generally recognized that ray therapy essentially is a surgical procedure. I frequently see patients with a cancer limited to the tonsil who have had cross firing with X-ray from a large front portal, a portal on the back of the neck, and one from each side of the face and neck. The treatment has resulted in intense dryness of the throat, in loss of hair, in irritation of the skin—particularly that of the ears, but has not altered the tumor. Indeed, the tumor has received inadequate treatment, although the patient has been very heavily dosed. The proper attitude toward such a condition is to determine accurately the extent of the growth, its geometrical relationship to surrounding structures, and, then, carefully to plan out the best method to apply a given dosage to the tumor and to avoid, so far as possible, radiation of any normal surrounding tissue.

There are available methods for determining the depth dosage, as compared to the surface dose of any X-ray outfit. Our tables, based on careful laboratory measurements, make a simple computation of the radium dosage with any desired arrangement comparatively easy.

In the case of X-ray, teleradiation from a source outside the body, is the only practical method so far devised. In the case of radium, there is teleradiation, contact radiation, by which the radium is placed on the surface of the growth as it presents in the mouth, and interstitial radiation—by which the radium is placed in the tumor itself.

Undoubtedly, all of these methods and the apparatuses for employing them are familiar to you. The X-ray apparatus is the usual 200 kilovolt machine. In Figures 6 and 7, are shown the apparatus which we have employed for many years in teleradiation. The skin distance and the size of the portals can be varied to suit the individual case. At 10 centimeters, each portal may receive 30 gram hours, at 25 centimeters, the dosage should not be greater than 25 gram hours.

Berven is convinced that the effects of teleradiation by radium are very much superior to those obtained by X-ray, and this is the consensus of all authors who have employed both methods. Coutard has obtained excellent results with X-ray alone. Personally, the author is moving toward the position of believing that the superior effects with radium are due to the methods of application rather than to an essential difference between the effectiveness of the two types of rays.

Under conditions of low ray sensitivity, such as is found with squamous cell epitheliomata, or under conditions in which, on account of the extent of the trouble, only a moderate dosage is possible, there seems to be every reason to believe that much better results are obtained by slow, continuous radiation over several weeks than by a single intense exposure. To some extent, this type of radiation may be simulated by giving daily, or twice daily, a treatment over a period of several weeks.

It is my opinion that contact surface radiation never should be employed in treating tonsil

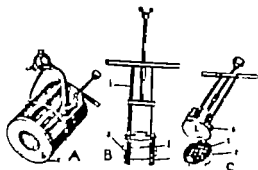


Fig. 6. Lead cylinder and plunger for holding radium.

cancer. It is very much less effectual than implantation and extremely difficult to carry out—both from the standpoints of effectually dosing the tonsil tumor and the protection of normal surroundings in the mouth.

The most convenient method of using interstitial radiation is by implantation of radon-containing tubes. These always should be covered either with a gold or platinum envelope. These radon tubes may have strings attached which permit of removal when the treatment is completed or they may be left permanently in the tissue. It is better to use large units of radiation and fewer of them. As a rule, a tonsil tumor such as shown in Figure 8, should receive a total of about 15 millicuries. The gland mass, shown in Figure 9, should have a similar amount. Whether 1 or 3 units are used will depend upon the shape of the tumor.

In employing teleradiation whether by X-ray or radium it is essential to use cross firing. Care should be taken to protect the salivary glands and the mandible. Figure 10 shows the position of 2 portals on the right side of the face. A third portal can be taken through the open mouth, and, if necessary 1 or 2 portals can be used from the



Fig. 8, left. Apparatus through mouth of interstitial cell epithelioma of tonsil.

Fig. 9. Appearance of neck, same case.

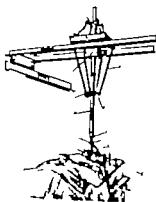


Fig. 7. Lead cylinder attached to supporting crane, car and track with patient in position during treatment.

opposite side. The beam, in each case, crosses in the growth. Two or three erythema doses may be given to the primary tonsil tumor in this way without overdosing the skin. Effectual radiation of the glands, by cross firing is more difficult. If the skin is fairly movable 2 portals—such as shown in Figure 11—can be employed. Sometimes a third portal may be utilized. With our telerradium arrangement, we always can secure three portals at a single level.

In the sensitive lymphosarcoma and lympho-epithelioma, everything can be accomplished by telerradiation. This applies both to the primary tumor and to the gland metastases. The actual technical procedures, however are greatly simplified by combining telerradiation with implantation. This type of combination is essential in most of the transitional cell epithelioma. In the squamous cell epithelioma, principal dependence must be placed on the implantation technique. Heavy implantation frequently is followed by sloughs which are very slow in healing and may lead to discomfort over a number of months. However if the growth actually has disappeared, these areas heal and the functional result is very good.



Fig. 10, left. Portals used in X-ray cross firing of tonsil. A third portal can be taken through the mouth.

Fig. 11. Portals for radiating glands of neck.

When the histological picture is that of a low grade epithelioma and there are movable glands, and when these glands do not disappear from the radiation, the indication is to remove them surgically. If the glands are fixed, it seems probable that surgery, even for the purpose of applying radiation, has only a very limited value. For the primary tonsil tumors, there would seem to be no real field for surgery. In the very low grade tumors, if they are well limited, it might be possible to obtain a complete removal by electro-desiccation, but this method surely is not so radical, nor effectual, as direct implantation with radium.

CONCLUSIONS

As with cancer elsewhere, it is evident that the percentage of cures depends on the extent of the trouble, and that every effort should be made to get patients in for treatment early. It should be kept in mind also that the prognosis and the treatment itself depend on the type of malignancy, and that, if radiation is employed, it should be carried to a dosage far beyond that necessary to cause a primary recession, or disappearance, of the growth. It should help to realize that a tonsil cancer, especially if it is of high grade malignancy, possibly may be cured even when there is extensive gland involvement. The surgeons should take up

radiation as a new surgical instrument and not consider it as something versus surgery, but as a valuable addition to their armamentarium.

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UNRUPTURED INTERSTITIAL PREGNANCY¹

ALBERT MATTHEU M.D. F.A.C.S., AND WILLIAM W. WILSON M.D., PORTLAND, OREGON
 From the Departments of Gynecology and Gynecologic Pathology, University of Oregon Medical School, Portland, Oregon

THE chief difficulty in the diagnosis of unruptured interstitial pregnancy lies in the extreme rarity of its incidence. It was only at autopsy prior to 1893 that interstitial pregnancy was recognized. In that year Traub performed a supravaginal hysterectomy and found an interstitial pregnancy and in the same week Lawson Tait found another at operation.

The report of Tait's case is most interesting. He writes: "On the morning of October 22, 1893, I was engaged in examining a specimen sent to me for an opinion, which proved to be an interstitial tubal pregnancy removed from the body of a patient who had died from an intraperitoneal hemorrhage, when there was carried into my consulting room on a stretcher a patient. He then describes a case in which he made a diagnosis of suppurating cyst of the broad ligament and which at operation proved to be an unruptured interstitial pregnancy. This is the first report published in English of an unruptured interstitial pregnancy found at operation.

Since 1893 there have been a fair number of cases reported, 79 having been collected by Moore previous to 1912. From perusal of the literature one concludes that 1.5 per cent of ectopic pregnancies are of interstitial variety; of these, one fifth are unruptured and found only at operation.

Interstitial pregnancy takes place in that portion of the tube which lies within the wall of the uterus. This portion of the tube is the smallest in caliber, the shortest, and the least subject to torsion. It is highly probable that ischemic nodosa, the so called sphincter of Kennedy, the presence of small fibroids in this region, or a pathological condition of the endometrium might be contributing factors to the etiology. It is also apparent that the etiological factors of this type of ectopic pregnancy are the same as for other types.

The symptoms are obviously those of the ordinary ectopic pregnancy. Upon examination, moreover, one should be able to feel an enlargement in one horn of the uterus. This applies, of course, only to the unruptured variety for with the ruptured interstitial pregnancy examination might be unsatisfactory due to rigidity of the abdominal muscles. Enlargement of one horn of the uterus, associated with symptoms of ectopic pregnancy, should always bring to mind the possibility of interstitial pregnancy.

We concur with Dutchen, who says: "Once the diagnosis is made or suspected, the treatment is immediate operation. Resection of the affected cornu may be sufficient in some cases. In others hysterectomy is necessary. The diagnosis usually cannot be confirmed without microscopic examination. Most writers agree that anything short of supravaginal hysterectomy can result in very profuse hemorrhage, and unless one is desperately anxious to save the uterus a supravaginal hysterectomy should be done.

CASE REPORT

The patient, aged 38 years, was admitted to Multnomah Hospital December 1, 1930, complaining of (1) vaginal bleeding, (2) pain in the lower abdomen, (3) enlargement of the abdomen, and (4) sudden loss of fluid from the vagina. She had been well, with all day menstrual cycle, until August, 1930, when the menstrual period was delayed for a week. Vaginal bleeding then started and continued almost constantly for over a month. The flow increased following abortion, and was excessive at the menstrual period. At the dispensary on October 24, she was examined and told that she had a tumor of the uterus. Bleeding stopped on November 1 and started again on November 7 when she thought she was having her normal period. This flow lasted until December 5. On December 5 she lost considerable clear slightly blood stained fluid from the vagina. For the two days following she experienced continuous dull pain in the left lower abdomen, and felt weak and dizzy. There have been two full term children and two miscarriages, one at 1 1/2 months and one at 2 months.

For several years the patient had infrequent attacks of periodic pain in the right upper quadrant of the abdomen, which radiated through to the back. The last one occurred 6 weeks previous to her admission to the hospital, lasted 24 hours, and was accompanied by mild icterus and anorexia.

Physical examination disclosed an obese middle-aged female, not in acute pain or distress. Her general examination was negative except for positive full-bladder sign and tenderness on both sides of the lower abdomen. The pelvic examination showed old induration of Bartholin's glands. There was serous sanguineous cervical discharge and moderate relaxation of the cervix. Bimanual examination revealed smooth, fleshy cervix. The fundus was anterior and enlarged and contained firm growth the size of a Japanese orange in the region of the left cornu. The adnexa were negative. The blood and urine were normal. Although hysterosalpingography was not done in this case, the use of this method would probably have made the diagnosis just prior to the operation, while the patient was under the anesthetic. Bimanual examination was again made. At this time the uterus felt as before. There was large nodules in the left horn of the uterus, attached to and part of, the corpus. The adnexa were negative. The pre-operative diagnosis was uterine myoma.

Operation was carried out December 7, 1930. The abdomen was opened between the umbilicus and sym-

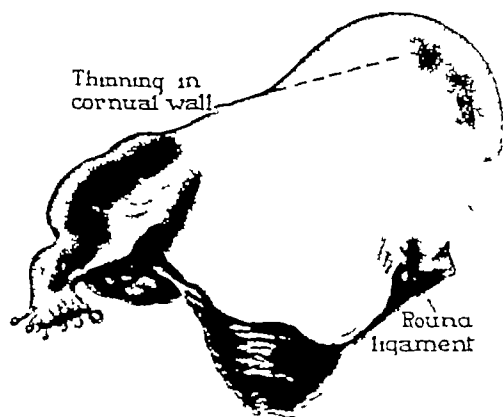


Fig 1 Reconstructed drawing of specimen just after removal. Note that tumor mass appears to be part of uterus.

physis. There were adhesions about the gall bladder, but no evidence of gall stones. The cæcum was large, dilated, thin walled, and blue, with multiple cobweb adhesions extending over it and the ascending colon. The appendix was normal. There was a large ruptured cyst of the right ovary and marked varicosities in the pampiniform plexus on both sides. A small corpus luteum cyst was seen in the left ovary. The uterus was found to be considerably enlarged. The entire left horn of the uterus was occupied by a rounded mass about 6 centimeters in diameter. This mass was quite soft but not fluctuant. At its very top was an area 2 centimeters in diameter which seemed thinner than the rest of the wall, and it had a purplish tinge as though there was blood or a blood clot beneath. The mass in the left horn caused marked distortion of the corpus and the left appendages. The left tube appeared to be pushed around behind the uterus and was coming off of the mass well to the rear. The round ligament appeared to be below its normal position in relation to the body of the uterus. The three classic characteristics of interstitial pregnancy, as presented by Ruge, were noted in this case: (1) asymmetry of the uterus (there was marked elevation of the corpus on the

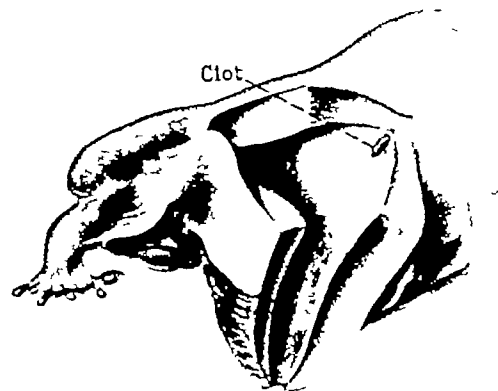


Fig 2 Shows uterus opened through its anterior wall. Note small uterine opening into intramural part of tube.

affected side), (2) asymmetry of the adnexa (the tube was displaced backward and downward), (3) displacement of the round ligament (the round ligament was displaced downward). Supravaginal hysterectomy was done both tubes and the right ovary were removed, and the adhesions about the cæcum were relieved by cutting. The abdomen was closed in the usual manner. The postoperative diagnosis was: (1) corpus luteum cyst of the left ovary, (2) ruptured corpus luteum cyst of the right ovary, (3) chronic cholecystitis, (4) blue cæcum (cobweb adhesions), and (5) unruptured interstitial pregnancy in the left cornu of the uterus. The postoperative course was uneventful and the patient left the hospital on the fifteenth day after operation. An Aschheim-Zondek test on the patient's urine, taken the morning after operation, was negative.

Pathological report. Formalin fixed specimen. The specimen consisted of the corpus uteri, the right tube and ovary, and the isthmic portion of the left tube. The uterus, which has been previously opened, was asymmetrically enlarged to about twice normal size. Except for an increase in substance the musculature appeared normal. The uterine



Fig 3 The tumor mass, about 6 centimeters in diameter, is shown opened in the cornu.

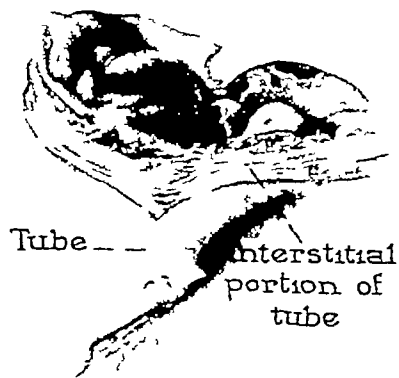


Fig 4 Posterior view of opened tumor mass. Note thickness of uterine wall around the pregnancy.



Fig 5A. High power photomicrograph of corporal endometrium contiguous to the interstitial tumor. Normal glands and stromal cells. No evidence of decidual reaction.

Fig 5B. High power photomicrograph of sections through the hematomaous mass and contiguous uterine

muscle showing presence of degenerating chorionic villi.

Fig 5C. High power photomicrograph of section through the isthmus-interstitial junction of the left tube within a few millimeters of the tumor. No decidual cells or chorionic villi are observed.

cavity although slightly enlarged, was normal in contour. The perimetrium and endometrium appeared normal.

The left uterine cornu embraced a hematomaous mass which has been opened for examination. The internal surface of the mass which evidently possessed a large central cavity consisted of numerous irregular convolutions of dark red, homogeneous friable material covered with a smooth, grayish blue, almost transparent membrane. The tumor measured 4.5 centimeters in its widest diameter and was everywhere surrounded by several millimeters of uterine muscle. The tumor did not bulge into the uterine cavity. Sections through the tumor and contiguous uterine muscle revealed an irregular collection of hematomaous material and muscle. In places the muscle in immediate contact with the hematomaous material had the gross appearance of hyaline thrombi while beyond this the muscle appeared normal. The isthmus portion of the left tube on serial section appeared normal. The uterine or interstitial condition of this tube traversed the musculature for a few millimeters and opened abruptly into the hematomaous mass. The right tube and ovary were essentially normal. Microscopic findings. Sections of the uterine muscle showed rather diffuse myometrial changes which, in places contiguous to the basal layer of endometrium, contained numerous implantations of normal uterine glands and stromal cells. Many of these adenomatous areas were situated several millimeters beneath the endometrium and were completely surrounded by myometrial tissue.

The endometrium was somewhat thinner than normal and was composed of uterine glands and stromal cells which showed hypertrophic changes characteristic of premenstrual endometrium. In places the basal layer had invaded the intermuscular septa. These glands and stromal cells showed no evidence of the pronounced hypertrophy noted before. A few however had undergone cystic changes.

Sections through the hematomaous mass and contiguous uterine muscle showed in general an unorganized blood clot rather firmly bound to a layer of uterine muscle. Embedded in the blood clot were numerous degenerating chorionic villi. Interspersed between blood clot and uterine muscle was an irregular zone of ill developed and degenerating decidual cells. The source adjoining the decidual layer appeared hyperplastic and was diffusely infiltrated with small numbers of round cells and polymorphonuclear leukocytes. Capillary dilatation and edema were present but not constant. A degenerating chorionic villus was observed in a venous channel near the blood clot. The isthmus portion of the left fallopian tube at its insertion in the

fundus was essentially normal. The right tube and ovary were essentially normal.

Diagnosis. Interstitial pregnancy. Myoma uteri with adenomatous changes contiguous to the basal layer of endometrium.

Certain pathological findings in this case are worthy of note in that they serve well to substantiate the diagnosis of interstitial pregnancy. The finding of an essentially normal uterine cavity lined with endometrium which showed no evidence of pregnancy changes should eliminate any question as to the possibility of intra-uterine participation in the gestation. Likewise, the finding of a normal fallopian tube which opened into the hematoma within a few millimeters of its uterine insertion removed all suspicion of an extra-uterine tubal pregnancy. Finally, the composition of the tumor and its interstitial location with respect to the fallopian tube is substantial evidence in favor of the diagnosis of interstitial pregnancy.

SUMMARY AND CONCLUSIONS

In this case the symptoms of ectopic pregnancy were apparently overshadowed by the signs of a bleeding uterine fibroid, and examination under anesthesia did not alter this impression. The rarity of unruptured interstitial pregnancy and the shape of the uterus found on bimanual examination led away from the true diagnosis. The Aschheim-Zondek test was negative because the fetal elements had probably been dead a long time. The sudden gush of fluid mentioned in the complaint was probably due to the rupture of the sac. An enlargement in one cornu of the uterus, associated with symptoms of ectopic pregnancy, should always bring to mind the possibility of interstitial pregnancy. Reconstructed drawings and photomicrographs are shown as proof that this case was one of true interstitial pregnancy.

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OVARIAN PREGNANCY

LANNING E LIKES, B S, M D, F A C S, LAMAR, COLORADO

SINCE true ovarian pregnancy is rare, I feel justified in reporting a convincing and interesting case. About 92 cases were described by Dorsel as cited by Zimmermann in 1927.

R M Mayne states that the term "ovarian pregnancy" is used to designate that type of gestation which takes place in the structure of the ovary, and for physiological and anatomical reasons has come to be classified by the writers into the primary, and the secondary or so called abdominal types. The former is to be considered as meaning the fertilization of the ovum before its liberation from the graafian follicle, with subsequent development of the embryo entirely within the substance of the ovary. The secondary type is considered as the fertilization of the ovum after its liberation from the graafian follicle with development upon the surface of the ovary, broad ligament, or elsewhere, and with encroachment upon the nearby ovarian tissue.

The first reported case was that of Catherine Van Tussenbroek in 1899, and a few years later Thomson demonstrated another case.

In order to be accepted as an ovarian pregnancy, certain criteria must be complied with—criteria laid down by Spiegelberg, namely that the tube is intact and has no organic connection with the gestation sac, that the tumor is connected with the uterus by the utero-ovarian ligament, that the walls of the sac contain graafian follicles in various places, and that the albuginea of the ovary passes directly into the tumor wall. To these demands Norris adds that the tube on the affected side should show no microscopic evidence of gestation. It seems unreasonable to insist that an embryo be found *in situ*.

In an article published by Carl F Heijl in 1927, he writes that in 1893 Maurange had described a case of peritoneal hæmorrhage from a ruptured hæmorrhagic cyst in the ovary, but until after the publication of the works of Schauta and Burger in

the beginning of this century these hæmorrhages were thought to come from ruptured hæmatomata in the corpus luteum or ovarian follicles without any connection with ovarian pregnancy. Several of these cases have been described that seem to support this theory.

Forsner came to the conclusion that sometimes ovarian pregnancy cannot be excluded even when careful serial examination of the clots in the ovary and abdomen for fetal elements yields negative results, pregnancy is not really disproved until some other pathological change is shown that would explain the hæmorrhage.

A Hæubner writes that Webster originally (1895) denied the possibility of ovarian pregnancy chiefly because it does not contain the endometrium necessary for the development of the human ovum, or as he calls it, "Mueller's tissue." But in 1904 he saw a case that he himself thought was extrafollicular ovarian pregnancy, which showed decidua-like cells on the inner surface of its walls which consisted partly of hyalin-fibrous connective tissue and partly of typical ovarian tissue. These were found also as the lining of hæmorrhagic cysts of the wall and of the rest of the ovary. He thinks that these accumulations of cells have the same origin as the ectopic foci or decidua cells that he saw in intra-uterine pregnancy. As he found these foci only on the serosa of the uterus and the uterine appendages he thinks that they were derivatives of displaced parts of Mueller's ducts. Ovarian pregnancy takes place by embedding of an ovum in such displaced Mueller's tissue in the ovary which then shows a decidual reaction.

Lyle A Sutton says that, in such cases, the early death of the embryo may be due to deficient blood supply, to some tissue reaction antagonistic to its development, such as that of the epithelial cells within the luteal cells, or in most cases to massive hæmorrhage. In almost all cases, the chorionic villi have been found to be lying in a blood clot.



Fig. 1. An anterior view of a slightly enlarged uterus, normal tubes, and a ruptured, bleeding left ovary definitely connected to the uterus by the utero-ovarian ligament.



Fig. 2. A posterior view of a slightly enlarged uterus, normal tubes, and a ruptured, bleeding left ovary definitely connected to the uterus by the utero-ovarian ligament.

The hemorrhage may be due to rupture of the gestation sac, or to perforation of the ovarian capsule. Sampson has shown that, during menses, especially in the presence of an obstruction to the flow or during operation on menstruating women, the menstruum, containing fragments of endometrium or of tubal mucosa, may pass through the tubes into the peritoneal cavity. The endometrial transplants may become implanted upon the ovary or other structures; they react to menstruation and to pregnancy as to any other müllerian tissues. Bleeding of the implants during menses may cause ovarian hematomata. A fertile ovum may become imbedded in a müllerian implant and find a favorable soil for its development.

The possibility of tubo-ovarian pregnancy should be considered in all cases of apparent ovarian pregnancy. Tubal pregnancies usually terminate by abortion or by rupture and the liberated ovum may become reimplanted in a ruptured graafian follicle, or upon an endometrial implant, stimulating primary ovarian pregnancy. It is known that chorionic villi cannot long survive when free in blood.

Ovarian pregnancy may take one of several courses. Full term pregnancies with living fetuses

after operation have been reported in the literature. The most usual course is an early ovarian abortion. This is followed by slight or severe peritoneal hemorrhage. The ovum is usually destroyed at this time but a secondary implantation may result in an abdominal pregnancy. The embryo is rarely found in these ovarian abortions, frequently chorionic villi are found.

Carl F. Hellpaks asks: "Can there be spontaneous recovery from an ovarian abortion?" Forrester refers to a case published by Gilles in which chorionic villi were in the peritoneal clot. In Bovin a case of pregnancy in tuberculous tube some villi were found in a clot but none in the tube itself. Finally Traugott in 1916 published an especially instructive case of copious abdominal hemorrhage from the adnexa. In this case there were corpus lutea hematomata on both sides and in the blood in the abdomen a small premature ovum to which a few small pieces of tubal mucous membrane were adherent. On careful examination of one tube, which appears to be normal, in serial sections, fibrin and syncytial cells were found at one place. Abeles in his dissertation describes a similar case to which Traugott refers. Schoenhof emphasizes the fact that there must be spontaneous recovery from tubal abortion with only slight clinical symptoms and complete anatomical restoration to be normal. It is probable that there must be a similar course in ovarian abor-

tion too When ovarian hæmorrhage ruptures into the abdomen it is known that the ovum may be wholly, or partially carried with it Or it may undergo degeneration after its implantation has been destroyed, it may be phagocytized, absorbed, and replaced by connective tissue

A chorio-epithelioma may develop from an ovarian pregnancy Voigt in 1925 collected the known cases of primary epithelioma of the ovary since Kleinhaus demonstrated this disease in 1902 Like Kleinhaus, other authors including Iwace, Klotz, Sunde, and Ries accepted ovarian pregnancy as the cause of their cases

REPORT OF CASE

N G, aged 27 years, married, temperature, 97.2 degrees, height 5 feet 5½ inches, weight, 113 pounds, pulse, 120 and thready, respiration, 28 She had the ordinary diseases of childhood—measles, mumps whooping cough, and chicken pox Menstruation started when she was 15 years old, was regular, every 28 days She married on January 1, 1927 Menstruation was normal and regular until the present difficulty She had had no miscarriages

On May 6, 1929, she menstruated for 5 days, and the flow was normal June 30, 1929, at 12 p.m. she had a severe, sharp pain in the lower left side of abdomen, and there was a vaginal discharge of bright red blood The flow continued At 10 p.m., after retiring, patient was awakened, was nauseated, and vomited undigested food At this time she fainted The next morning Dr Hamilton was called and made a vaginal examination An enema was given and hot packs were put to abdomen That afternoon, July 1, 1929, Dr Hamilton returned and advised the patient to come to hospital He made a diagnosis of ruptured tubal pregnancy

Upon admission to the hospital, the patient's pupils were contracted because of the morphine which had been given her for the pain She was extremely pale and gave the appearance of being very ill The abdomen was rigid Hæm-

oglobin was 55 per cent, red blood corpuscles 3,187,000, white blood corpuscles 7,200, urine, negative The previous diagnosis was confirmed and immediate operation was advised

While patient was on the operating table, under ethylene gas a vaginal examination was made and a mass could be felt high in the left pelvis There was some uterine bleeding at this time The abdomen was opened through a central incision, and considerable free blood and clots were found The uterus was enlarged to about the size of a 6 weeks' pregnancy, the left ovary was the size of a large English walnut and gave the impression that it had exploded It was bleeding rather freely from the raw surface The tube and ovary were removed and the raw surface was covered

This case fulfills all the criteria of Spiegelberg in that the tube on the affected side was smooth, open at fimbriated end and gave no signs of rupture or inflammation In serial section the tube appeared normal The fetal sac occupied the position of the ovary, chorionic villi were found penetrating the wall in several places They were also present in some of the blood clots This ovarian mass was definitely connected with the uterus by the utero-ovarian ligament

It might be interesting to note that on May 5, 1931, this patient was delivered, without much difficulty, of a living, healthy, 7 pound girl

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THE LIFE HISTORY OF A LITHOPEDION

FRED EMMERT M.D. St. Louis, Missouri

From the Department of Gynecology and Obstetrics, St. Louis University School of Medicine and St. Mary's Hospital

IN the constantly growing literature on lithopedion we find very few cases in which the correct diagnosis was made before operation. The increasing frequency with which radiological examinations are being made, may bring about a marked change in the recognition of such conditions. No one, however has as yet been privileged to observe the evolution of a lithopedion from beginning to end. The following case report, therefore, may lay claim to a more general interest.

We have to deal with a woman of 30 years who at the very end of her second pregnancy had mild labor pains which soon disappeared, at the same time all movements of the fetus ceased. Not until one whole month later did she consult her family physician, Dr. Zeller to whom I am indebted for the following details of the case.

The abdomen was greatly enlarged and the fundus extended to the costal margins. The cervix was of normal size and the os closed. No fetal heart tones could be heard. An X-ray picture (Fig. 1) revealed a large fetus lying in transverse presentation, the head on the left. Dr. Zeller planned to do a version and breech extraction, but the patient refused to submit.

This happened September 5, 1923, that is to say almost 8 1/2 years ago. At the present time, the patient can no

longer remember whether or not she had had any discomfort during her pregnancy which might conceivably be interpreted as an interruption of an existing fetal or ovarian position.

By January 7, 1934, as Dr. Zeller's notes show, the abdomen had become a little smaller and the top of the abdominal mass had receded somewhat. A second X-ray photograph (Fig. 2) revealed the fetus in an unchanged position and of about the same size. Dr. Zeller now made a diagnosis of an abdominal pregnancy that had gone beyond term, but his urgent advice for operation was steadfastly refused by the patient, for, aside from the enlargement of the abdomen, she had no discomfort and even had gained in weight, and in fact, never felt better in her life.

Regular examinations during the following year showed constant distention in the size of the tumor. Within a year the upper pole of the mass had receded about two fingers' width downward. In the summer of 1935, years after the first examination, the top of the tumor was at the level of the umbilicus. The patient had regular periods and no subjective symptoms whatever. Another X-ray picture (Fig. 3) showed the fetus still in the transverse presentation, but the convexity of the vertebral column was now more pronounced, the head was lower and smaller and the cranial bones were distinctly overlapping.

The following 5 years passed without any particular changes. In January 39 the patient went to a hospital



Fig. 1. September 5, 1923. Abdominal pregnancy, seventh post term. Transverse position, head on left side. Fundus at costal arch.



Fig. 2. Same case January 7, 1934. Fundus half way between transverse and midline. Fetal position unchanged.



Fig 3 Same case, 1925 "Fundus" at umbilicus. Fetus still transverse, but spinal column more curved and head smaller owing to overlapping of cranial bones



Fig 4 Same case, August 5, 1931. Hard tumor palpable immediately above symphysis. Calcified mass within which several long bones are visible

on account of a slight digestive disturbance for a thorough gastro-intestinal examination in the course of which the tumor was again discovered. There was now only a hard mass left which could be felt just above the symphysis. An X ray picture was made by Dr R L Sante, radiologist to St Mary's Hospital, whom I wish to thank for his permission to publish this case. This picture (Fig 4) shows a calcified mass in which some long bones, the only remnants of the fetus, can be discerned. On bimanual examination I found the uterus of normal size and mobility. Above and a little in front of it, there was a freely movable tumor of excessively hard consistency. Its shape was fairly round and its size that of a man's fist. I, too, urged operation, but the patient still objected to it.

In view of the perfect well-being of the patient, it might be open to question whether I was justified in advising operation. The literature contains many examples of extreme tolerance in women who have carried lithopedions without the slightest discomfort for several decades. On the other hand, there is no assurance that the calcified shell might not be absorbed in some place at any time and then a perforation of the fetal bones into some hollow viscus or even a fatal peritonitis would occur.

Whatever the ultimate outcome in this case

may be, we have here a unique observation which presents a multitude of unusual features, namely,

1 An abdominal pregnancy with a living child was carried to term without discomfort

2 No disturbance followed the death of the child, and at no time did the organism become conscious of the presence of a foreign body. Very gradually the soft parts of the fetus were absorbed, and the skeleton of the child very slowly moved from its original position at the costal angle downward toward the symphysis. We know positively, that the integrity of the fetal body was preserved for at least 3 years. Sometime after this, the fetal membranes became impregnated with calcium salts, and 8½ years after the spurious effort of labor, the formation of a lithopedion was complete.

4 A happy combination of circumstances had enabled us to follow this evolution of a lithopedion from its beginning to its very end, through a series of impressive X-ray pictures.

5 The gradual change from the size of a full grown child to that of a man's fist could be demonstrated.

6 In the literature on lithopedion no one has yet been able to tell at what stage of pregnancy the formation of the lithopedion may take place. The foregoing description proves that even a full term child cannot escape such a fate.

SUCCESSFUL RESECTION OF THE AMPULLA OF VATER, INCLUDING A PORTION OF THE DUODENUM WITH CHOLEDOCHODUODENOSTOMY FOR CARCINOMA OF AMPULLA OF VATER

WALTMAN WALTERS, M.D., F.A.C.S., ROCHESTER, MINNESOTA

Division of Surgery The Mayo Clinic

RECENTLY I successfully resected the ampulla of Vater including a portion of the duodenum and performed cholechochoduodenostomy for a carcinoma of the ampulla of Vater.

The patient was man, 50 years of age, whose only symptom was severe intestinal bleeding. His distended, normal colored gall bladder and common bile duct, the former not palpable through the abdominal wall, but unexpectedly encountered at exploration, led to localization of the lesion. There was no history of jaundice but for weeks there had been weakness, diarrhea, and shortness of breath. His normal weight was 70 pounds, but by the time he came to the clinic he weighed only 6 pounds. His blood pressure, in millimeters of mercury, were 90 systolic and 70 diastolic. His pulse rate was 100 beats each minute and his temperature 99.4 degrees F. There was a systolic murmur at the apex of the heart. The spleen felt soft and boggy. His family physician had told him that he was anemic, and on examination at the clinic his skin did have yellowish-brown color. Moreover, the concentration of hemoglobin was 33 per cent (Dare) and erythrocytes numbered only 1,680,000 in each cubic millimeter of blood. Leucocytes numbered 4,800 in each cubic millimeter of blood, and percentages of the various types of leucocytes were as follows: lymphocytes, 24; monocytes, 4.5; neutrophils, 63. Dr. Watkins reported that the blood smear did not give the picture of pernicious anemia, that regeneration seemed fairly good and that there was marked hyperchromasia. The urine was normal. Acidity of gastric content was as follows: total, 80, and free hydrochloric acid, 98 both in terms of cubic centimeters of tenth normal sodium hydroxide. The concentration of bilirubin was less than .5 milligram in each 100 cubic centimeters of serum and the reaction was indirect. Roentgenological examination of the thorax, stomach, and colon gave negative results. In test for occult blood, the stool reacted positively to benedictine and to guaiac on each of two occasions. July 22, 1932 the day before operation, transfusion of 500 cubic centimeters of citrated blood was given.

At operation, palpation of the duodenum in the region of the ampulla, although revealing some apparent thickening or enlargement, probably would have been disregarded had not the gall bladder been distended and the possibility of an ulcerating lesion of the ampulla as a cause of the hemorrhage been suspected. This possibility became probably after thorough examination of the small intestine, excluding the possibility of ulcer in the posterior wall of the duodenum, a tumor of the small intestine, or an ulcer in the tip of Meckel's diverticulum. The liver was not cirrhotic and the possibility of bleeding oesophageal varices was thereby eliminated.

Incision began at the pyloric sphincter, dividing it transversely, carried along the anterior wall of the duodenum for a distance of about 6.5 centimeters revealed an ulcerating lesion approximately 1 centimeter in diameter, involving the ampulla and the posterior wall of the duodenum. The mass with which this portion of the wall of the duodenum could be brought up for resection, as shown in Figure 3, was surprising. Resection of the entire thickness of the posterior wall of the duodenum, including the ampulla of Vater beginning 1 centimeter beyond the periphery of the lesion and carried to the pancreas, was accomplished, and the posterior wall of the duodenum was approximated by interrupted sutures of catgut, as shown in Figure 4. No attempt was made to isolate or identify the pancreatic ducts, for it was felt that the pancreatic fluid would leak channel between the interrupted sutures, which seemingly has proved to be the case. The common bile duct was divided immediately above the duodenum. The distal end was doubly ligated with silk and the proximal end anastomosed to the duodenum with silk, making an end-to-side anastomosis. Pyloroplasty was also performed to enlarge the outlet of the stomach. A portion of No. 18 catheter approximately 1.5 centimeters in length, was left in the anastomosis to serve temporarily as a scaffolding for healing and channel for the transmission of the bile.



Fig. 1. Adenocarcinoma, graded 2, of the ampulla of Vater.



Fig. 2. A section from the growth shown in Figure 1.

The pathological report was that the growth was an adenocarcinoma graded 2, of the ampulla of Vater (Figs. 1 and 2). The patient's postoperative course was uneventful.

August 14, the concentration of hæmoglobin was 36 per cent, erythrocytes numbered 2,910,000, and leucocytes 2,800 in each cubic millimeter of blood. There was moderate poikilocytosis, anisocytosis, and polychromatophilia, the percentage of reticulated cells was 3.8.

The patient returned home on the twenty-eighth day after the operation in good condition. At request, he returned to the clinic September 30, at which time his general condition was excellent. The concentration of hæmoglobin, which prior to operation had been 32 per cent, had increased to 50 per cent, and the number of erythrocytes had risen from 1,980,000 to 4,010,000.

The frequency with which tumors of the ampulla occur is indicated by the following summaries which have appeared in the literature. In 1906, Geiser collected 51 reports, in 1913, Outerbridge, an additional 59. In both groups 20 resections of the lesion had been carried out. Mueller, in 1925, collected 30 additional reports, in 8 of which resection had been done, and in 1927, Cohen and Colp tabulated 59 cases of tumor of the ampulla which had been reported from 1898 to 1925. Fulde, in 1927, reviewed 51 cases of papillary carcinoma of ampulla of Vater and added 1 case of his own. In this group were 42 cases in which transduodenal extirpation was performed in one stage, with a mortality of 42 per cent. A review of these papers and the collected cases, as well as of the cases seen at The Mayo Clinic, brings out several interesting points.

Einhorn and Stetten credit W. J. Mayo's report, made in 1901, as being the first of successful transduodenal extirpation of carcinoma of the papilla of Vater. The patient was deeply jaundiced, and preliminary cholecystostomy was performed. The growth was later removed by transduodenal resection, partly with a knife and partly with cautery. The patient was well for 18 months, when pain and icterus recurred. These symptoms were temporarily relieved by cholecystoduodenostomy.

Interesting patients from the standpoint of permanency of cure include one operated on by Koerte, which patient according to Clar remained cured for 17 years instead of 6 years as first reported, and Kelly and Burnam's patient whose case was reported by Lewis. This patient was well for 8½ years following resection of the tumor. Clar reported a patient living and well for more than 5 years which he stated was the fourth case in which extirpation of a papillary carcinoma of the ampulla of Vater had been performed and in which the patient lived more than

5 years. Interesting from the standpoint of palliation are 2 other patients whose cases will be reported toward the end of this paper, 1 of these 2 patients remained well 2 years and 9 months and the other, 2 years and 5 months, after resection of the ampulla of Vater.

In a consideration of resection of the duodenum and ampulla of Vater, with cholecystoduodenostomy or choledochoduodenostomy, for tumor of the ampulla of Vater, it is only fair to give credit to the palliative, conservative method of relieving the obstruction by anastomosis between the biliary and intestinal tracts and to call attention to Abell's interesting case in which radium was applied by a very ingenious method to the ampullary lesion. If the patient is deeply jaundiced, or if his condition is such that resection of the ampulla cannot be accomplished with a reasonable margin of safety, it would seem that the palliative operation of biliary intestinal anastomosis is indicated. On the other hand, if the patient is in good condition and the lesion small, producing symptoms such as bleeding, which may terminate the patient's life unless the lesion is removed, it would seem that resection should be undertaken. That cholecystostomy or cholecystgastrostomy as a preliminary to resection of the ampullary lesion in deeply jaundiced patients may be advisable, is evident.

In further support of the argument favoring ampullary resection in indicated cases is the relative benignity of carcinomata of the ampulla. They are mostly adenocarcinomata of low degree of malignancy, producing symptoms early and metastasis late. Emphasizing the delay in appearance of metastasis, Perry and Shaw reported metastasis in 3 of 15 cases. In 4 of the cases which Cohen and Colp reported from Mt. Sinai Hospital, necropsy was obtained, and in none were metastatic growths present.

The cardinal symptoms of the lesion are icterus, distention of the gall bladder, and chronic obstipation. Mueller called attention to the fact that probably the most common region of origin of the ampullary growth is the duodenal mucosa at the papilla where an ulcer may develop, and that jaundice, the main symptom, is present except in a few cases in which ulceration of the lesion permits a channel to form through it for the passage of the bile. The jaundice then will be intermittent or complete, depending on whether the bile is able to seek a channel through the lesion. This fact was emphasized by Einhorn and Stetten in their case, reported in 1924. There was almost total absence of jaundice, except for a slight attack at the beginning of the

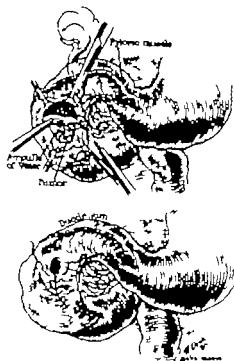


Fig. 3. Upper drawing: resection of the posterior wall of the duodenum, including the ampulla of Vater. Lower drawing: method of closure.

patient's illness, which they accounted for by the fact that the tumor was ulcerative in type and not actually obstructive. Cohen and Colp, in their summary described in detail the histological differences between the malignant cells which take their inception from the intestinal mucous membrane of the ampulla and those of choledochal tumors. In the former the cells are clear and flat in the latter cylindrical and rather high. The cells of tumors which take origin from the canal of Wirsung are cuboidal. Cohen and Colp have expressed the belief that other possible sources of origin may be from the glands of Lieberkuhn and the glands of Brunner and also from aberrant pancreatic tissue in the depth of the ampulla.

OTHER CASES

Besides the foregoing case the following cases have been observed at The Mayo Clinic. Three were proved cases of carcinoma of the ampulla of Vater in which cholecystenterostomy was performed in 2 and cholecystostomy in 1, 3 cases in which the lesion seemed to be tumor of the ampulla of Vater and cholecystenterostomy

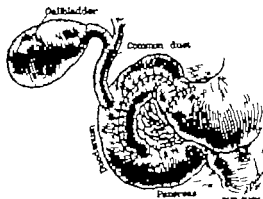


Fig. 4. Choledochoduodenostomy performed at the same operation as the procedures illustrated in Figure 3.

was performed 2 cases in which resection of the ampulla of Vater was performed, and the patients, who were in poor condition died and 2 cases in which resection of the ampulla of Vater was successful. In 1 of these last 2 cases Pemberton operated in 1924, and in the other Judd operated in 1928.

Pemberton's patient was a man, aged 44 years. He first registered at the clinic September 30, 1924, complaining of stomach trouble of "years' duration. He had had approximately twenty attacks in which severe epigastric pain was projected around both costal margins and through the body to the back. These attacks were of 15 to 30 minutes' duration, and were relieved by drinking hot water. Hypodermic injections of narcotic were not necessary. There was no jaundice and no vomiting. For year before his registration at the clinic there had been constant, gnawing discomfort, and loss of weight had been 50 pounds in 2 years. There was tenderness on pressure over McBurney's point. Total acidity of gastric content was determined as 74, and the value for free hydrochloric acid as 54. The quantity of gastric content obtainable was 140 cubic centimeters. The blood count as normal. The stomach and gall bladder were negative to roentgenological examination. The diagnosis was indeterminate, and abdominal exploration was advised.

At operation October 8, 1924, a gall bladder distended to grade 2, and small cystic duct were found. The common bile duct was enlarged, but did not contain stones. The pancreas was apparently normal to palpation. The wall of the appendix was thickened, and the organ was adherent to the mesentery of the cecum. Exploration of the stomach and duodenum revealed nothing abnormal. The appendix and the gall bladder were both removed. There were no gall stones.

The patient returned, January, 1925, with the history that 3 weeks previously pruritus had developed, and that this had been followed by gradually deepening jaundice, without pain. The concentration of hemoglobin was 43 per cent, and erythrocytes numbered 4,600,000 in each cubic millimeter of blood. There was no bile in the stool. Roentgenograms of the region of the gall bladder and duodenum revealed nothing abnormal. Exploration was made and complete obstruction of the common bile duct, due to carcinoma of the ampulla, was found. The common

bile duct was dilated to grade 3, and, when it was opened, it was found to contain white, flocculent, mucous material. The duct was explored with the finger, and, near the ampulla, it was contracted. A nodule of fairly soft consistence, about 2.5 by 1.5 centimeters was felt in the region of the ampulla. The duodenum was opened at a point near the common bile duct, the papilla evaginated, and the tumor found projecting from the ampulla into the lumen of the bowel. Microscopic examination of a specimen resulted in the diagnosis of colloid carcinoma. The growth was removed with clamp and cautery, and the pedicle ligated. Lateral anastomosis was made between the common bile duct and the duodenum. The cut end of one of the pancreatic ducts was sutured to the duodenal mucous membrane. The report of pathological examination of the entire specimen confirmed the diagnosis of colloid carcinoma and offered the probability that the growth had developed on a basis of papillary adenoma. Convalescence from this operation was uneventful. The patient regained his general health and was able to carry on light work for 21 months.

The patient was re-examined at the clinic September, 1926, at which time he stated that 10 days previously, he had had a chill, followed by vomiting, and since that time he had had dull, aching pain in the epigastrium, with slow, but progressively increasing jaundice. In the period after the operation on the ampulla his weight had increased to 198 pounds, but in this last illness he had lost 10 pounds. Roentgenograms of the thorax were negative. The concentration of bilirubin was 8.93 milligrams in each 100 cubic centimeters of serum and the reaction was direct. Tests for occult blood in the stool were positive with benzidine and with guaiac. No abdominal masses were felt. Exploration was made again September 20, 1926, at which time a rather firm mass, 10 or 12 centimeters in diameter, was found involving the second portion of the duodenum, and the nodes behind the duodenum. It was judged to be too extensive for surgical removal. He returned home a short time later, and notice of his death was received March 20, 1927.

Judd's patient was a man aged 38 years who first registered at the clinic October 15, 1928, complaining of painless jaundice of 3½ months' duration and loss of 47 pounds. He had had intense itching since the onset. The stools had been completely white until 1½ months before he came to the clinic and then had become yellow. There were no chills or fever. He was emaciated, and jaundice was graded 4. The edge of the liver extended to the umbilicus and its surface was nodular. The concentration of hemoglobin was 50 per cent, erythrocytes numbered 3,260,000, and leucocytes 8,800 in each cubic millimeter of blood. There was 19 milligrams of urea in each 100 cubic centimeters of blood. The concentration of bilirubin was 12.4 milligrams in each 100 cubic centimeters of serum and the reaction was direct. Roentgenologic examination of the thorax and stomach, and of the gall bladder, without dye, was negative. November 1, 1928, cholecystostomy and choledochostomy were performed. The gall bladder was large and dilated and the common bile duct tremendously dilated. A soft, movable tumor was found at the end of the common bile duct. A specimen, removed from this, was reported, after microscopic examination, to be tissue of a carcinomatous polyp. Because of intense jaundice and a long coagulation time, it seemed advisable

only to establish drainage of the common bile duct, postponing resection of the ampulla until later. Transfusion of blood was given twice before operation, and three times afterward. Transduodenal resection of the ampulla of Vater was performed December 21, 1928. The entire ampulla was excised and cauterized. Two transfusions were given following this operation.

The patient returned to the clinic August 9, 1929, complaining of soreness in the right upper abdominal quadrant and slight jaundice. The edge of the liver was barely palpable, it was rounded and a little tender. The value for serum bilirubin was 3.4 milligrams in each 100 cubic centimeters and the reaction was direct. The patient was operated on again September 9, 1929. Exploration revealed a stricture, or a recurring carcinoma, of the ampulla of Vater. There was slight induration in the region of the ampulla. Cholecystgastrostomy was performed. He returned to the clinic December 18, 1930, stating that, following the last operation, he had been perfectly well until October, 1930, when slight aching pain developed in the right upper abdominal quadrant, which gradually became severe until morphine was required to relieve it. There was no nausea or vomiting. The concentration of bilirubin was 1.2 milligrams in each 100 cubic centimeters of serum, and the reaction was indirect. Under medical treatment, including duodenal drainage with the Lyon tube, the patient's condition improved materially. There seemed to be no evidence of recurrence of tumor. April 13, 1931, he returned to the clinic with a history of progressive loss of weight since the last visit, continuation of pain and the occurrence of chills and fever about once a month. Blood was noted in the stomach content and stools. April 26, after a preliminary transfusion of blood, exploration revealed a tumor in the region of the head of the pancreas, and posterior gastro-enterostomy was done. There was no other evidence of metastasis. The patient received almost immediate relief from his pain and other symptoms of obstruction, was dismissed from the hospital May 11, and was allowed to go directly home, at which time his general condition was fair.

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RUPTURE OF THE PANCREAS

CHARLES S. VENABLE, M.D. F.A.C.S. SAN ANTONIO, TEXAS

IN reviewing the literature on rupture of the pancreas I have been impressed with the scarcity of information on the subject most of the references are to case reports based upon post operative diagnosis. The textbooks, too, are far from elaborating. True, rupture of the pancreas rarely occurs in comparison with the frequency of rupture of other solid viscera within the abdomen. It is also true that it may not be recognized many times when it should be, and because of the serious results which follow rupture more consideration should be given to the possibility of its presence in making a diagnosis following injury to abdominal viscera.

The symptoms vary in the different degrees or types of complete and incomplete rupture and depend much on whether or not rupture of the gland is associated with hemorrhage or whether after a period of apparent recovery from the initial period of severe symptoms following the injury a subsequent hemorrhage supervenes. With these factors in mind, an early, careful study and a consideration of the possibility of pancreatic injury seems most important in making a differential diagnosis in the presence of traumatic lesions of the abdominal viscera. Early recognition with resultant prompt intervention seems the factor necessary to lower a mortality apparently far too high.

Embryologically the pancreas is encased in peritoneum, but as the fetus develops the posterior surface is covered with connective tissue while the borders and anterior face are continuously covered with the reflection of peritoneum—the posterior wall of the lesser peritoneal cavity—and so this organ becomes encased in its only capsule. The lesser cavity in turn is enclosed anteriorly by the gastrophatic omentum, stomach, gastroduodenal omentum, and mesocolon, having connections with the greater peritoneal cavity only through the foramen of Winslow.

The pancreas lies across the ascending vena cava and abdominal aorta opposite the bodies of the first and second lumbar vertebrae and over the dense dorsal muscles behind, while in front, besides lying within the arch of the upper abdomen with its strong muscle support, it is also protected from injury by a pneumatic cushion, the stomach, and a water pad, the fluid content of the lesser peritoneal cavity. Because of the intricate functions of the pancreas, so essential to life, and be-

cause of its extremely pliable texture, it would seem that nature had provided for it the most protected location of any organ in the body.

The secretions of the pancreas are steapsin, trypsinogen, amylase, and from the islands of Langerhans, insulin. Without going into the subdivisions of the chemistry of these ferments, their function is respectively fat digestion by steapsin, and starch digestion by amylase, while trypsinogen is inert until activated by bile, duodenal contents or necrotic tissue, when it becomes trypsin and an active digestive agent for proteins. Insulin, of course, has only to do with sugar metabolism.

This will explain why diet plays such an important rôle in the treatment of pancreatic injury as these secretions are each increased or diminished in output in accord with the demand made by the character of the food intake. It also explains the varying degrees of tissue necrosis as well as the various treatments recommended, including what has apparently been the rather empirical drainage of the gall bladder—a procedure which lessens the back pressure of bile into the pancreatic duct and so diminishes the activation of trypsinogen in the gland, which, if activated, is inert. It is this back pressure of bile or the necrosis of pancreatic cells following injury which, through autolysis, changes trypsinogen into trypsin with resulting digestion of vessel walls and causes the frequently noted delayed or secondary hemorrhage.

With this brief anatomical and physiological foreword, it is evident why injury to the pancreas of sufficient force to cause rupture is of much less frequent occurrence than rupture of the liver or spleen or kidney but like these being a solid organ, the pancreas is torn by *crush* being unable to transmit the wave force created by the blow which is directed through its substance—the ship on the rocks is soon torn to pieces by the waves while a vessel afloat can withstand the terrific force of a storm crashing against its side.

I believe that this method more reasonably explains the cause of rupture of a solid viscus, particularly of the pancreas, than does the idea usually expressed that the pancreas has been crushed against a vertebral body. The latter theory certainly does not explain rupture of the pancreas beyond the vertebral body.

Rupture may be in the substance of the pancreas within its immediate peritoneal covering

Such a rupture may be termed "incomplete" It may, however, include a rent in the "capsule" when the rupture is called "complete" Either type may or may not be associated with concurrent or subsequent hæmorrhage The cause of rupture is usually a severe trauma to the upper abdomen directed backward, though there are a few cases reported as having been caused by a blow on the back At the immediate time of injury, differentiation between complete and incomplete rupture is impossible unless there are present obvious signs of hæmorrhage when of necessity the rupture is complete.

The outstanding symptoms of pancreatic injury are usually emphasized by collapse and pain Immediately there is collapse of the same type as that brought about by a blow in the solar plexus, indeed, a blow in the solar plexus, which may occur simultaneously with injury to the pancreas, has much bearing on the severity of the early symptoms because a solar plexus injury is characterized with much more intense symptoms than those caused by rupture of other abdominal organs There is extreme pallor, dyspnoea, cyanosis about the lips—a sign emphasized by Halstead as characteristic—cold sweat, rapid pulse, and fall in pulse and blood

Pain is usually commensurate with the collapse, very severe in the epigastrium and frequently so in the back Moynihan says "that no other condition produces such unendurable agony and such profound collapse." I think that this statement is possibly misleading, for while such usually obtains there are many cases of record in which neither the pain nor the collapse was so pronounced, occasionally, the initial injury has been considered trivial

The upper abdomen is usually rigid while the lower abdomen is tense, which condition lasts for from 1 to 3 or 4 hours There is a distinct splinting of the diaphragm, particularly on the left, which continues, though less marked, after the abdominal muscles relax Initial vomiting is the rule, but this vomiting is only of gastric content and contains no blood As the condition of collapse subsides and the upper abdomen softens, the nausea disappears, the pulse regains its volume and the rate becomes normal, respiration is less embarrassed, the rhythm being regained and the rate of 18 to 24 returning, though the diaphragm remains somewhat splinted At this stage, unless there is hæmorrhage, it may be very difficult to differentiate the condition from that caused by a blow to the solar plexus or by severe trauma to the pancreas or other upper abdominal viscera If, however, the syndrome suggestive of severe

injury persists, the presence of a pancreatic rupture should become more than a suspicion or suggestion

As the subsequent course of events is more characteristic, however, the diagnosis will become clarified There persists a spasm of the upper rectus muscles with localized tenderness, most marked on the left The patient complains of pain or soreness in the epigastrium or back, which may be intense and intermittent or constant This pain is most suggestive of incomplete rupture and is due to increased swelling which creates a tension within the peritoneal covering or "capsule" The pain is promptly relieved when the "capsule" gives way and the tension is suddenly released The condition is similar to that associated with rupture in a fulminating appendicitis—a period of well-being, covering the interval before the formation of a pseudopancreatic cyst, follows, if no hæmorrhage takes place

If ambulatory, which the patient may be during the period of well-being, he walks stooped over holding his hand to his upper abdomen, or he suffers varying discomfort when he stands erect. When the stomach is empty, nausea may be absent but vomiting of food or water is characteristic, particularly when the patient is not in the prone position The vomiting is caused by embarrassment to the pylorus and first portion of the duodenum—the early closure of the foramen of Winslow, characteristic in the presence of insult within its confines, has caused a collection of pancreatic fluid in the lesser peritoneal cavity and this in turn produces distention The fluid produces no other symptoms and has no effect on the peritoneal surfaces unless the trypsin has become activated or unless steapsin has found its way to attack fat in the mesentery or omentum

The statement by Mocquot, Costanum, Sistrunk, and others, following their investigations, that pancreatic fluid has no effect on peritoneal surfaces, must have been based on the findings in cases in which the trypsin remained inactivated and the steapsin was in insufficient quantity or had not the material on which to work. As borne out by investigations of Coffee, Mocquot, Costanum, Sistrunk, and others, the physiological function of the pancreas is to supply its various ferments only on demand, and this fact must always be reckoned with in anticipating or estimating the potential damage the ferments may cause

As the pancreatic fluid collects, slower or faster as the case may be, a tumor mass in the upper left paramedial abdomen is formed over which the stomach is flattened and so is unable to retain but a small amount of the intake of fluid or solid

Consequently the loss of weight is rather rapid and the increase in size of the upper abdominal tumor progressively pronounced until in some cases it may reach below the umbilicus.

Between the time of the initial disability caused by incomplete rupture and the subsequent breaking down of the so-called "capsule" and formation of the pseudocyst of the pancreas, with its mechanical syndrome, there may elapse days, or weeks, or months, or even years. However the possibility of the trypsinogen becoming activated and the consequent danger of hemorrhage or rupture of the pseudocyst into the general peritoneal cavity should always be borne in mind.

According to Honigsmann's table, as published by Stern who cites 48 cases, the duration of time lapsing between the occurrence of the injury and the appearance of the tumor is shown in the following: 3 cases in first week, 3 in second week, 10 in next 2 weeks, 9 in second month, 14 in succeeding 3 months, 7 in succeeding 5 years and 1 in eighth year.

If the rupture is complete in the beginning, the continued severity of pain, nausea, vomiting, rapid pulse, and early tumor formation is suggestive in making the differential diagnosis between complete and the more usual incomplete rupture in which the rupture occurs within the first few days of observation. However should a tumor mass rapidly develop, there must be an associated hemorrhage, e. g. the rapid filling and distention of the prepatellar bursa about the knee following trauma associated with hemorrhage.

During the interval of improvement or well-being and the return to normal or near normal as to circulation and body tone, the pulse is changed in character only in proportion to the malnutrition and general debility. The temperature is slightly subnormal for the same reason, while respiration is embarrassed only because of the high and more fixed diaphragm on the left. Urine output is dependent on fluid intake and the stool to some extent on food supply.

In some of the case reports, an ileus is described, but I am not satisfied that this is of different purport than it is when associated with other severe abdominal trauma. There are no early blood changes, such for instance, as the presence of a leucocytosis, which would indicate free blood in the peritoneal cavity; subsequent changes may show deficiency in hemoglobin and red blood cells only in keeping with the lowered metabolism. The urine is normal except as may be explained in later fluid deficiency and continued illness.

I have attempted to describe the course of events in the formation of the two types of cysts

of the pancreas: (1) the pseudocyst which may be slow in forming and not be recognized for weeks or months, or even years, the reason being that a balance of pressure or even healing of the pancreatic rent may have occurred so that the patient complains only of a tumor or merely fullness in the upper abdomen with or without digestive disturbance; and (2) the very rapidly forming cyst associated with extreme mechanical epigastric distress and persistent vomiting requiring rather prompt surgical relief.

An associated hemorrhage presents a very different picture and its recognition depends on whether the hemorrhage is immediate or late. If immediate one knows only that an upper abdominal viscus has been ruptured causing a hemorrhage, but it is impossible to tell whether it is the liver or pancreas which has been ruptured, although probably the spleen can be excluded because of the localizing symptoms peculiar to injury of it. Thus, the surgeon is confronted with an acute, traumatic, surgical abdomen.

In many of the cases of rupture of the pancreas, however, delayed or secondary hemorrhage complicates the condition, so that early recognition is imperative and surgical interference urgent.

The immediate syndrome following injury is that of incomplete rupture: the patient is in a condition of collapse, has epigastric pain, the abdomen is intensely rigid, the diaphragm fixed, etc. These symptoms may subside but there is a recurrence of symptoms with rapidly progressive intensity associated with restlessness, increasing pulse rate, lowering of pulse pressure, thirst, general and increasing abdominal distention and rigidity. In short the picture is that of intra-abdominal hemorrhage: the symptoms appearing suddenly following a period of quiescence. It may be better compared with the picture produced by a ruptured ectopic gestation with its typical syndrome.

As is always true of the presence of free blood within the peritoneal cavity the blood picture now changes promptly to a rapidly increasing leucocytosis. Even if the symptoms of hemorrhage are not so severe in onset and do not progress as rapidly as described and it is found by comparison of the blood count at the time of injury and later that there is an increasing leucocytosis, this factor is of paramount importance in making a diagnosis. Therefore, blood counts should be frequently made during observation.

When a diagnosis of rupture of the pancreas is made or reasonably suspected, because of the continuation of suggestive symptoms, prompt surgical intervention should be undertaken.

I believe, particularly if rupture is incomplete, that early intervention during the period of reasonable well-being following the initial phase of collapse, will reduce the very high mortality, for then we make use of the opportunity offered by a period of election when work may be more thoroughly done and with far less hazard than in the presence of secondary hæmorrhage when the patient is again approaching extremis. This opinion is based on a review of a large number of cases, one case which I am reporting seems particularly illustrative of this point. It would seem also that the morbidity may be shortened, as less opportunity for the activation of trypsinogen would have occurred. Even though no lesion is found, an exploratory operation seems of little significance compared to the danger to be combated should emergency arise.

The choice of approach is the paramedial incision around the inner border of the left rectus which is retracted outward. The peritoneum is entered through the bed of its belly. The tumor mass, with the stomach flattened out over it and possibly with the gastrocolic omentum and transverse colon lifted up by it, now presents. The great omentum and transverse colon are lifted out of the wound and reflected upward so that the mesocolon, distended over the lower margin of the tumor, is exposed. The tumor mass is obviously fluid transmitting a colorless appearance unless there is hæmorrhage when it is bluish. The abdominal cavity is walled off by means of packs, an opening is made through the mesocolon into the lesser cavity, and the fluid is withdrawn by a suction apparatus. When the fluid is withdrawn the opening through the mesocolon can be easily enlarged to permit of easy access to the pancreas. Any bleeding point is ligated and the rent in the pancreas is sutured, particular pains being used to preserve and protect the pancreatic duct. In suturing the pancreas its extreme friability should be remembered and the sutures not drawn too tightly, also as catgut is an animal tissue and, though chromicized, will be promptly digested, linen is the preferable material to be used at this stage. Silk is possibly admissible as the animal substance will probably withstand long enough to permit union. I mention these facts because of an experience I had in closing a pancreatic rent with No. 00 chromic catgut in which the wound remained perfectly dry for 4 days when drainage of pancreatic secretion became profuse.

Means for subsequent drainage should be instituted, for which purpose a small rubber tube (about No. 15 F) is threaded through the gastrocolic omentum into place when the opening in the

mesocolon is closed. The tube is stabilized by means of a pursestring suture in the gastrocolic omentum and brought out of the abdomen through a stab wound lateral to the abdominal incision, which is now closed in the usual manner. The tube is connected to a container on the side of the bed and in this manner most of the pancreatic ferments, which are so destructive to tissue, may be carried off, the amount of drainage observed, and its character and change recorded.

This record is important and interesting, for the character of the fluid is controllable by diet. Wahlgemund first suggested in 1910 the value of an antidiabetic diet which has been in general use since then. In the treatment of a case Fast found that the addition to the diet of 2 ounces of karo each 24 hours reduced the secretion from 4 to 2 ounces daily. Amylopsin does not have any effect on tissue while trypsinogen, unless activated by bile or necrotic tissue, whether caused by bacteria or otherwise, is inert and is easily subject to control by diet. By a rigid antidiabetic diet the secretion may be made almost trypsinogen- and steapsin-free, while with the addition of proteins and fat they will reappear. An alkali should be given, as the hydrochloric acid of the stomach excites the flow of trypsinogen. For this purpose, I found recently that calcium gluconate could be taken over a long period with none of the distress incident to too much sodium bicarbonate. Taka-diastase or pankeron, or some similar pancreatic substance may be given to make up for the secretion lost through drainage.

Incident to drainage there is some leakage around the tube, however well placed, so that it is necessary that skin protection be provided. In a recent case I found xeroform to offer the most perfect skin protection, there was not even redness of the skin at any time and no desquamation. In a case of severely destructive wound necrosis, Fast used Witte's pepton locally with good results. For the same reason that an alkali is given to neutralize the acid of the stomach, decinormal hydrochloric acid has been suggested and used locally in an attempt to control wound necrosis due to pancreatic ferments, but I concur in the belief that it is of value because it incites the flow of trypsinogen. The use of meat extract about these wounds is also contra-indicated because it helps to form trypsin. Both the mortality and morbidity in wounds of the pancreas are largely dependent upon the quality and quantity of the pancreatic juices liberated. Far the greatest harm is done by trypsin, which has been found to be the outstanding factor in the creation of the complications and sequelæ I have described.

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The following five cases seem to illustrate the most salient points in the early recognition of this condition as set forth in this article and as described in reports of cases from the literature. I am indebted to Drs. W. B. Russ and Omer Roan for the opportunity of presenting two of the cases.

CASE 1. H. W. girl aged 17 years, was admitted to the Leo Surgical Hospital, August 13, 1914. She had been thrown from a horse 3 days previously, in which time she sustained a scalp wound and a blow in the abdomen from the pommel of the saddle. She was in severe shock from which she recovered in an hour or so, but she continued to complain of pain in the epigastrium. The scalp wound was not serious. The next day she was much improved and the third day was up. The fourth day the pain and distress in the upper abdomen had returned, and had progressively increased in severity. On admission to the hospital on the fifth day the child was obviously ill, with pallid and anxious expression, nausea, but no vomiting; pulse, 80, temperature, 100, respiration, 20 and thoracic. The abdomen was rigid and particularly tender in the epigastrium. The blood count showed red blood cells, 4,800,000; hemoglobin, 70 per cent; white blood cells, 5,300. A diagnosis of injury to the abdomen was opened no free blood was made. In the cavity and no injury to the liver or spleen was found. An opening through the gastric omentum could be made and a tumor mass of purplish hue involving about a inches of pancreas and extending downward about 3 inches retroperitoneally was disclosed.

The posterior peritoneum was incised and the necrotic tissue and disorganized blood clot were removed. A drainage tube was inserted into this cavity and brought out through the abdominal wound. The drainage was removed 48 hours when it began to clear and become serous. Efforts to guide it into the container were unsuccessful as was protection of the skin with zinc oxide, so that tissue necrosis was severe. On the seventeenth day there occurred a very profuse secondary hemorrhage which was controlled by packing. Following the secondary hemorrhage the drainage gradually subsided and the child was discharged December 8, 1914, generally improved but with a sinus which finally closed in February, 1915.

CASE 2. M. W. T. male, aged 2 years, was admitted to the Leo Surgical Hospital, November 6, 1914. The day before entrance, he had been kicked in the abdomen in breaching a stool. The injury was followed by epigastric pain, abdominal pain, collapse, and the vomiting of gastric contents. In a few hours the general condition of the patient had improved but the pain in the abdomen and the repeated doses of morphine. When he entered the hospital his general condition was fair, the pulse, 100; temperature, 99; respiration, 21 and somewhat thoracic with partially inflated left diaphragm. The upper abdomen was fairly rigid and there was a distinct space of the upper left rectum. The lower abdominal muscles were not in spasm. There was no nausea but an anorexia, no abdominal distention. There has been no stool but he had passed gas 4,000,000; hemoglobin, 82 per cent; white blood cells, 8,500. The Wassermann reaction was negative. The urine was normal.

This condition continued throughout the succeeding 48 hours, with no abatement of pain. A diagnosis of probable injury to the liver or pancreas was made, and an exploratory laparotomy was done. A high left rectal incision was

made but nothing abnormal was found when the abdomen was opened. The stomach was distended but was relieved by means of a transverse incision, and a small hard mass could then be felt through the stomach wall in the region of the pancreas. An opening through the gastrotomic incision was made and the pancreas was exposed. A mass about the size of half an egg was found on the pancreas behind the distended posterior peritoneum; this was incised and about 3 ounces of serous fluid was removed. There was an irregular rent about 1 by 3 centimeters in the substance of the gland a fingerbreadth from the left spleen. This was brought together by two looping linen sutures and the "capsule" was closed. A drainage tube was placed at the site of the opening and brought out through the gastrotomic incision in a separate opening and through the abdominal wall. The gastrotomic incision and the abdominal wall were closed in the usual way by layers. Through the drainage tube a small amount of serous fluid, then serous, fluid was conducted into a container. Pancreatic ferment never appeared in the drainage. The tube was withdrawn on the ninth day and the skin wound closed spontaneously 3 days later. The abdominal wound healed per primam.

Convalescence was unremarkable and the patient was discharged on the twentieth day. A rigid acid-fast diet was instituted at the beginning and maintained for 8 weeks. I have seen this man twice since and he has remained well. Neither during his immediate postoperative convalescence nor since has there been any evidence of sugar intolerance.

CASE 3. Miss R. C., aged 1 year, came into the M & S Hospital March 30, 1910, because of a slowly developing tumor mass in the upper abdomen, and incessant vomiting. This patient gave a history of a fall, 1 week before admission, on a picket fence, one of the pickets striking her in the epigastrium. At the time she had great deal of pain in the upper abdomen with some vomiting. The pain lasted for a few hours but she was so well that she attended school the next day. On the third day nausea because so marked that there was frequent vomiting, midway after the intake of any liquid food. The doctor noticed at this time small mass in the epigastrium about next 4 days this mass gradually increased in size, and the nausea and vomiting became worse.

On admission to the hospital the child was fairly comfortable in bed, and only when she moved about or when at those vomit some bile-stained material. Nothing in particular was found on physical examination except the mass in the epigastrium in the midline, about the size of an ordinary orange. The mass was quite tender and was not movable.

Laboratory examinations at this time showed the following: urine had specific gravity of 1.020, with albuminuria showed a few pus cells and rare red blood cells. Before operation the blood count showed 8,500 white blood cells with 90 per cent polymorphonuclears, 5 per cent small lymphocytes, 1 per cent large lymphocytes, 5 per cent eosinophils.

The probable diagnosis was ruptured pancreas, hemorrhage, and the patient was ruptured pancreas with to be an accumulation of blood that had collected in the lesser peritoneal cavity, thus causing a protrusion of the stomach and gastrotomic incision. The omentum was opened about midway between the stomach and transverse colon, and the gastrotomic incision was opened over the head of the pancreas. There was now revealed ruptured

pancreas that was still oozing. Gauze packing was placed in this area, and drainage through the gastrocolic omentum was established, and the wound was closed. The patient had a rather stormy convalescence. On the third day all of the packing was removed. After that there was a great deal of drainage of pancreatic juice, with an associated irritation and some digestion of the abdominal wall. This condition prevailed for about 2 weeks. The first 3 or 4 days the amount of drainage was practically a liter in 24 hours, but the amount gradually decreased. There was never any change in the blood sugar, and never any evidence of colonic irritation during the time of profuse pancreatic drainage.

Her general condition remained as good as could be expected. About the end of the second week the drainage suddenly stopped. She improved steadily and on April 26, 1929, was discharged in good condition.

CASE 4. Miss G. L., aged 17 years, was admitted to Nix Hospital July 9, 1931. Patient had been in an automobile wreck June 14, 1931. She was riding in the rumble seat when the car struck a tree and she was thrown forward, striking the upper part of the abdomen against the ledge of the car. She sustained an injury to the nose at the same time. She was not knocked unconscious, but felt very sick and weak, with a severe pain in the stomach. She was given a hypodermic and went to sleep. The next day she felt better but still had some pain in the stomach and upper abdomen and was nauseated. From that time the abdomen became gradually enlarged. On admission to the hospital she was walking in a stooped position, had no energy, and was easily fatigued. She could not keep anything on the stomach and the vomitus was green and bitter. For the past 10 days she had had severe pain constantly, but now there was no pain when lying down.

Examination on admission revealed an underdeveloped and poorly nourished girl of 17. She appeared anemic, the skin had a very peculiar color, though she seemed not acutely ill. General examination was negative except for the abdomen, which presented a large, symmetrical tumor mass, filling the ensiform region and extending down on the left to below the umbilicus. This mass was tender to palpation, but the distention was too great to elicit muscle spasm. The tumor was distinctly fluid.

The temperature was 99, pulse, 80, respiration, 20, thoracic. The blood count showed red blood cells, 4,180,000, hemoglobin, 81 per cent, white blood cells 7,100. The urine showed albumin 1 plus, no sugar.

The pre-operative diagnosis was ruptured pancreas, pseudopancreatic cyst.

Through a left, high paramedial incision, the left rectus was retracted to left and the peritoneum entered behind the muscle belly. The stomach was flattened over a large fluid mass which completely filled the lesser peritoneal cavity. The liver and spleen were normal. The greater omentum and transverse colon were lifted out through the upper angle of the wound and the lower abdomen was protected with a wet saline pack. The presenting cyst wall was now entered by means of blunt dissection through the mesocolon and 2,200 cubic centimeters of murky fluid evacuated. An oblique rent through the capsule across the pancreas about halfway through its substance was now seen. There had been no bleeding. The rent was closed with No. 00 chromic catgut, and a rubber tube was passed through the gastrocolic omentum, placed, and brought out through the abdomen. The opening in the mesocolon was now closed, the colon replaced and the abdomen closed in the usual way.

Examination showed that the fluid removed was not digestive of protein, was faintly digestive of fat and entirely digestive of starch with amylase almost entirely in predominance and with trypsinogen not activated. There was

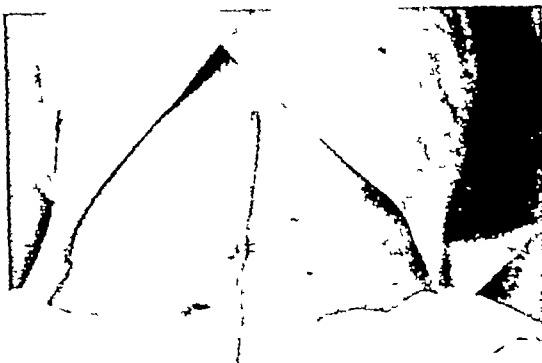


Fig. 1. Photograph in Case 4, showing wound healing without destruction of abdominal wall or skin.

a medium amount of sero-sanguineous drainage the first 24 hours, after which there was no drainage until the fourth day, when the drainage of clear fluid became profuse, which on examination was found to be amylase. This drainage continued in varying amounts of from 12 to 3 ounces to a few drams, in 24 hours until August 3, when it entirely stopped. Repeated tests showed a predominance of amylase.

A rigid antidiabetic diet was maintained and steady improvement of her general condition continued with no sugar imbalance. The abdominal wound healed *per primam*, and at no time was there an irritation by digestive ferment of the wound or skin which was kept covered with a thick paste of xeroform.

Patient was discharged from the hospital August 12, 1931, ambulatory, with wound and sinus entirely closed. Subsequent examination September 26, 1931, showed that she had gained 11 pounds, that she had had no digestive disturbances, the skin clear, and that she felt perfectly well.

One observation of interest to me in this case was the apparent activation of trypsinogen by the catgut used in the suture of the pancreas and with its subsequent digestion in contrast with the entirely dry wound in Case 2, when linen was used for suture material.

CASE 5. M. J. S., male, aged 56 years, was admitted to the Nix Hospital, July 7, 1931. He had cranked an automobile in gear and had been thrown against a work bench, striking himself below the left costal margin. Immediate pain was severe and he felt very sick and faint. After a short time he walked into the house, complaining of pain in the region of the left loin and left upper abdomen and of extreme weakness. An hour later, about 11 a.m. he was seen by his physician, who stated that as he was not in any great pain or shock no treatment would be instituted but he advised the patient to remain at rest and report any symptoms that might arise. A few hours later the pain in the upper abdomen recurred, was associated with weakness and a feeling of faintness, so he was sent to the hospital at 4 p.m.

The complaint on admission to the hospital was dull pain in the left upper quadrant of the abdomen, especially on any manipulation of this region. The pain was described

more so as an uncomfortable feeling associated with general weakness.

The patient was in shock, the skin was pale, as were also the conjunctivae and mucous membrane of mouth. The pupils were equal and reacted to light and accommodation. Chest expansion was equal on both sides. Breath sounds and resonance were good. There was only slight external evidence of injury to the upper abdominal wall. On palpation tenderness and bulging of the abdomen lateral to the spleen were noted. Pressure elicited pain and tenderness in this region and on percutaneous dullness was noted. Peristalsis could be heard. Blood pressure was 80-90; pulse, 76; temperature, 97.6 degrees; respiration, 20. The blood count showed red blood cells 4,800,000, white blood cells 15,150; polymorphonuclears 86 per cent. Urinalysis showed albumin but no sugar.

A pre-operative diagnosis of ruptured spleen was made. Operation was done at 5 p.m. The abdomen was opened through a high left paramedial incision. Some free blood was found in the abdomen but there was no injury to the liver or spleen. The lower peritoneal cavity was filled with blood. An opening through the gastrosplenic omentum was made and the blood was evacuated. The pancreas had been wounded through the capsule, the rupture going completely through the gland to the left of the midline. A spurting vessel was ligated, an unsuccessful attempt was made to enter the gland, and, the hemorrhage being controlled, the wound was closed. The patient became capillary and progressively worse and did not respond to supporting measures. There was a continuous rise in temperature to 101 degrees F. and an increase in pulse rate beyond 160, when the patient died at 8 p.m., the second morning or 38 hours after operation.

At necropsy the peritoneal cavity was found filled with a thick fluid mixed with blood, many lymph plaques and areas of fat necrosis, while within the lesser cavity there was a collection of serous fluid mixed with blood and serous secretions of both sides of the wound in the pancreas.

This case illustrates that the severity of a lesion in the substance of the pancreas may not always be measured in terms of the severity of pain or the extremeness of collapse. It is apparently this sort of exception that makes it so difficult to lay down a rule and if there be a rule makes it so hard to follow. If anything this case may suggest the value of an early blood examination very close and careful observation, and possibly the pro-

priety of early exploratory operations, when the possibility of injury to the pancreas is persistently suggestive.

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THE SURGICAL CORRECTION OF UTERINE DISPLACEMENTS

ONE HUNDRED CONSECUTIVE CASES OPERATED UPON BY THE MODIFIED GILLIAM METHOD

ANTHONY WOLLNER, M.D., F.A.C.S., NEW YORK

Associate in Gynecology, New York Post Graduate Medical School and Hospital, Columbia University, Attending Obstetrician, St. Vincent's Hospital, New York

THERE are few gynecological entities to which so much interest and consideration have been devoted as has retrodisplacements, their symptomatology, and treatment. The facts that for a considerable time no uniform opinion could be formed regarding the proper mode of treatment, and that the surgical correction of retrodisplacements left the relief of symptoms uncertain, account for the numberless contributions to the literature. The recurrence of symptoms following operative correction has led to numerous modifications of the surgical technique. Dr. Van de Velde in 1910, at the Gynecological Convention held in St. Petersburg, reported 217 different surgical methods. Since then additional variations of technique have been suggested.

The publication of a large series of cases observed and operated upon by the same individual, by means of the identical operative procedures, may afford valuable information and serve to support already established principles in the treatment of this condition.

The present series of cases consists of 100 in which surgical correction was performed in young women still in the reproductive age period. All of these cases are from my private practice and were followed up by myself for a period of 15 years.

In establishing the indications for surgical correction I have observed the following principles: retrodisplacements without symptoms require no treatment, and therefore in such cases, to avoid unnecessary worry or the illicitation of imaginary symptoms, the patient is not informed of the presence of the condition. In cases in which no extragenital origin of the symptoms could be found, and in which the patient's complaints were believed to be produced by the pelvic pathology, surgery was advised, except in the presence of contra-indications. One such contra-indication is retrodisplacement concomitant with adnexal disease, which would necessitate the removal of the adnexa. Operation in this type of case should be avoided during the reproductive age period. Other contra-indications are general debility, marked asthenia, lesions of vital organs, etc.

The use of pessaries should be reserved for temporary correction, as in the first few months of pregnancy, or when the patient refuses to undergo

an operation. It has been my experience that pessaries do not cure retrodisplacement, and that after their use for a period of years, the removal of the pessary leads to the recurrence of the original symptoms. The disadvantages of the pessary method of treatment are well known but the importance and significance of the psychological effect produced by the foreign body in the vagina has been too little emphasized. In several cases under my observation, the continued use of the pessary caused inhibition of sexual desire and led to serious marital maladjustment. In all cases in which the correction of the retrodisplacement is indicated, the pessary should not be a method of choice. However, the pessary may be a valuable aid in diagnosis and in determining whether or not the symptoms are actually caused by the retrodisplacement or whether the retrodisplacement of the uterus is coincidental with other pathology. In those cases in which the symptoms are alleviated by the insertion of the pessary, a permanent surgical correction is definitely indicated.

All of the following cases were operated upon by the modified Gilliam method. The operative procedure is as follows: The abdomen is opened by a small midline incision extending downward to a point directly above the pubis. The fascia and peritoneum are incised in the linea alba. The patient is placed in Trendelenburg position and the intestines pushed upward by means of a pad. The uterus is then brought forward into the correct position and both round ligaments are grasped with clamps. A small opening is made in the fascia on both sides and a clamp is pushed through the muscular layer and peritoneum. The round ligament is brought through the newly formed canal and is fixed to the outer surface of the fascia, two silk worm gut sutures being used on each side for this purpose. The round ligament is not shortened, only a small loop being fixed above the fascia. This technique varies from the original Gilliam method at two points. First, the ligament itself is not shortened, but simply fixed above the aponeurosis. Shortening of the round ligaments is not essential in the attainment of a permanent satisfactory result. The fixation of a small loop above the fascia, when its distance from the uterus is properly selected

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serves the purpose well, and thus the free mobility of the uterus is insured. The second modification of the original technique is the use of silkworm gut as suture material for the fixation of the round ligament. It is important that stress be placed on securing a permanent fixation of the ligament, and this is accomplished by using non-absorbable suture material. Some authors (Graves, Barrows) report the occurrence of infection following the use of silk ligatures, which in certain instances required the removal of the suture. Gilliam observed suppuration in a considerable proportion of his cases. In the present series of cases in which silkworm gut was used exclusively no complications were observed due to the suture material. There was not even marked tenderness around the ligature.

I adhered to this operative procedure in all my cases because I consider it the simplest and quickest procedure. It also gives good and permanent results without distorting the normal pelvic anatomy.

Table I shows the results in one hundred surgical cases. Under the heading "fair result" are recorded those cases in which the uterus was found to be retroceded without having assumed an extreme pathological position.

TABLE I.—RESULTS

Number of cases
Followed up
Excellent result
Fair result
Recurrence

Cases
100
77
65
0

There was no mortality. Postoperative complications were of minor importance, such as secondary union of the abdominal incision due to septic discharge from the fat tissue of the abdomen. Postoperative cystitis occurred in 4 cases. Serious complications such as herniation of the abdominal scar or intestinal obstruction, which have been reported by various authors, were not observed in any of my cases. It seems remarkable that in the 77 cases which were followed up for a considerable period of time after operation, no recurrences were found.

Thirteen patients in this series became pregnant subsequent to the operation and 4 aborted in the second and third month. Investigation revealed that in two of these cases the abortion had been induced, while in the other two cases the cause of abortion remains unknown. Five cases, in which gravidity occurred, were under my care during their pregnancy and were personally delivered. These pregnancies were uneventful except for moderate discomfort in the

lower abdomen during the first 4 months. This discomfort was probably caused by traction on the suspended ligaments. No symptoms due to the suspension were observed in the latter months of pregnancy. Labor was in no way influenced by the previous operative procedure, and in each instance following delivery the uterus again resumed its corrected position.

In reviewing these surgical results, the conclusion may be drawn that permanent correction is assured by the simple method described. Complicated surgical procedures, which frequently distort the normal anatomy are unnecessary for the purpose of accomplishing permanent suspension of the uterus. Dannreuther, who in his recently published paper reviews his extensive material, consisting of 180 cases, operated upon by six different surgical methods, emphasizes that "no single technical procedure is universally applicable." The fact that the etiology and mechanism of retrodisplacement is complex, suggests that no routine procedure for its correction is to be advised. Every case of retrodisplacement requires careful pre-operative study with reference to the changes in the pelvic anatomy. According to my experiences the modified Gilliam method cannot be considered a routine procedure as it is possible to individualize each operation by selecting the proper distance of the round ligament loop from the uterus and also by varying the proper site on the fascia where the fixation is to be made. The possibility of varying the relationship between these two points to each other gives ample latitude for adapting the operation to the individual requirements. In applying this method it is essential that as much deliberation and study be given the suspension of the ligament as to any plastic operative procedure.

At the time of operation one frequently discovers pelvic pathology which could not be detected at the pre-operative examination of the patient.

Table II lists the additional procedures found necessary in my 100 cases.

TABLE II.—ADDITIONAL PROCEDURES

	Cases
Total number of cases	100
Freeing of pelvic adhesions	36
Vaginal repair	30
Cervix	30
Amputation of cervix	3
Salpingectomy	3
Myomectomy	3

In 13 cases the diseased condition of the adnexa was so extensive that their removal was necessary. As previously stated, I do not advise any

operation in young women which might interfere with the reproductive function, but in these cases it was necessary to remove the adnexa because the pre-operative examination did not reveal the extent of the pathology. In the 3 cases in which myomectomy was performed, the fibroids had not been found previous to operation. The myomata were of subserous type and of moderate size. In almost all cases the appendix was removed as a prophylactic measure, but it is interesting to note that the histological findings of the removed appendices revealed pathological changes in 54 instances. These additional findings indicate that a large number of cases which are diagnosed pre-operatively as simple retrodisplacements are complicated by other pathological conditions. It is, therefore, inadvisable to utilize an extraperitoneal operation for the correction of a retrodisplacement and at the time of operation it is essential that a careful exploration of the abdominal organs be made to determine the possible presence of any condition not diagnosed prior to operation. When undertaking a surgical procedure for the correction of retrodisplacement, it is well to remember that the patient consults the gynecologist for the alleviation of certain symptoms and the restoration of her health and not primarily for correction of the displacement. Since in many cases it is impossible to determine whether the symptoms are caused by the retrodisplacement or some coincident pelvic pathology, it is not sufficient simply to perform a routine ventral suspension. In each case a thorough exploration of the pelvic cavity should be made and the appendix should be removed.

A follow-up examination with special reference to the alleviation and cure of the primary symptoms is less satisfactory than the anatomical results of the surgical procedure.

Table III lists the chief complaints and the results following operation in the 77 cases which were followed up.

It is disappointing to note that in approximately 60 per cent of these cases the operation failed to bring about the subsidence of the symptoms of backache and abdominal pain. This is particularly discouraging as every effort had been made prior to operation to eliminate any possible extragenital origin of the symptoms. The etiology of the symptoms of backache and abdominal pain remains obscure, and since positive knowledge of the exact physiological mechanism involved is lacking, their interpretation remains a matter of speculation. The high percentage of recurrence of these symptoms after successful ventral suspension indicates that, even when careful pre-

TABLE III—CHIEF COMPLAINTS, RESULTS

Symptom	Total	Cured	Improved	No change
Pain in lower abdomen and back	68	27	12	29
Menstrual disorders (dysmenorrhœa, menorrhagia, and metrorrhagia)	48	44	2	2
Bearing down sensation	26	18	6	2
Urinary symptoms	10	8	1	1
Leucorrhœa	37	27	8	2
Sterility	12	7		5

operative study is made, it is impossible to rule out other causative factors. It is therefore unwise to promise a patient permanent relief or cure by means of surgical intervention.

In those cases in which the chief complaint was a menstrual disorder, correction of the retrodisplacement was followed in the majority of cases by complete alleviation of symptoms. Here again, however, the disappearance of symptoms cannot be ascribed entirely to the correction of the malposition, as in all such cases with menstrual dysfunction a curettage was performed prior to laparotomy. Even if the curettage plays a dominant rôle in the cure of the menstrual dysfunction, the correction of the retrodisplacement may be an important factor in the prevention of the recurrence of pathological changes in the uterine mucosa, which were originated by the displacement.

Marked improvement was also observed following operation in those cases in which bearing-down sensation and urinary symptoms constituted the chief complaints. A study of the cases in which there was unsatisfactory postoperative relief from symptoms revealed the following attendant conditions. Each of the following abnormal conditions were found to be present in one of the cases in this group: neurosis, chronic anæmia, general debility, tuberculosis, nephrolithiasis, cholecystitis. These findings may very well account for the failure of subsidence of symptoms following the operation.

The supposition that retrodisplacement of the uterus may be a causative factor in the production of sterility is not sustained by the findings in this series of cases. Theoretically, the anatomical and physiological changes in the uterus caused by circulatory disturbance may be a factor in sterility, but practical experience contradicts this assumption. In the present series only 16 patients

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serves the purpose well, and thus the free mobility of the uterus is insured. The second modification of the original technique is the use of silkworm gut as suture material for the fixation of the round ligament. It is important that stress be placed on securing a permanent fixation of the ligament, and this is accomplished by using non-absorbable suture material. Some authors (Graves, Barrows) report the occurrence of infection following the use of silk ligatures, which in certain instances required the removal of the suture. Gilliam observed suppuration in a considerable proportion of his cases. In the present series of cases in which silkworm gut was used exclusively no complications were observed due to the suture material. There was not even marked tenderness around the ligature.

I adhered to this operative procedure in all my cases because I consider it the simplest and quick est procedure. It also gives good and permanent results without distorting the normal pelvic anatomy.

Table I shows the results in one hundred surgical cases. Under the heading "fair result" are recorded those cases in which the uterus was found to be retrocanted without having assumed an extreme pathological position.

TABLE I.—RESULTS

Number of cases
Followed up
Excellent result
Fair result
Recurrences

Cases
100
77
65
18
0

There was no mortality. Postoperative complications were of minor importance, such as secondary union of the abdominal incision due to serous discharge from the fat tissues of the abdomen. Postoperative cystitis occurred in 4 cases. Serious complications such as herniation of the abdominal scar or intestinal obstruction, which have been reported by various authors, were not observed in any of my cases. It seems remarkable that in the 77 cases which were followed up for a considerable period of time after operation, no recurrences were found.

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lower abdomen during the first 4 months. This discomfort was probably caused by traction on the suspended ligaments. No symptoms due to the suspension were observed in the latter months of pregnancy. Labor was in no way influenced by the previous operative procedure, and in each instance following delivery the uterus again resumed its corrected position.

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TABLE II.—ADDITIONAL PROCEDURES

Total number of cases
Fringing of pelvic adhesions
Vaginal repair
Cervix
Amputation of cervix
Salpingectomy
Myomectomy

Cases
100
36
39
30
3
3
3

In 13 cases the diseased condition of the adnexa was so extensive that their removal was necessary. As previously stated, I do not advise any

INCIDENCE AND PREVENTION OF PERIVESICAL SUPPURATION FOLLOWING SUPRAPUBIC CYSTOTOMY¹

LEWIS T MANN, M.D., NEW YORK

From the Surgical Services of Mount Sinai Hospital, New York City

DURING the last few years, there have appeared in the modern literature articles by various authors, emphasizing perivesical cellulitis and suppuration following suprapubic cystotomy as the predominant cause of death. Williams, J. H. Neff, E. L. Keyes, and V. Vermooten have offered various operative procedures as means of preventing such suppuration.

Neff follows the technique of Williams and does what he calls a two-stage cystotomy, packing the space of Retzius with gauze and subsequently entering the bladder in about 4 to 7 days. He states that 20 per cent of his one-stage prostatectomies and one-stage cystotomies were infected, with more or less fascial sloughing.

Adopting his new technique of two-stage cystotomy, he did 78 prostatectomies in 32 months, using preliminary exposure in 50 per cent of the cases with one death, cause not given.

Keyes states that pelvic cellulitis is the most dangerous complication to suprapubic bladder operations and believes that the mortality is much greater in suprapubic than in perineal prostatectomy. He estimates that the mortality of suprapubic cystotomy preliminary to prostatectomy is 10 per cent. At Bellevue, from 1917 to 1922, there were 33 deaths in 102 preliminary cystotomies for prostatectomies. He states that pelvic cellulitis is the predominant cause of these deaths but gives no case reports or autopsy findings. In view of this mortality, he recommends the three-stage operation and describes the technique of packing off the perivesical space as a preliminary to opening the bladder at a subsequent operation. Using this procedure, he did 29

suprapubic prostatectomies without mortality. Among an equal number of one-stage cystotomies, 2 died before prostatectomy. He believes that by doing a two-stage cystotomy the tedious waiting for a patient to recover from pelvic cellulitis before doing the prostatectomy, is eliminated.

In doing suprapubic lithotomy, he has had many deaths in the past which were attributed to poor renal function, but now he believes these patients died of pelvic cellulitis. No figures or autopsy reports whatever were cited by Keyes.

V. Vermooten, in a recent publication, cites these papers in which there is the assumption that perivesical suppuration is the cause of high mortality following suprapubic cystotomy. Most of the prostatectomies done at New Haven are by the perineal route, and preliminary cystotomy is only done when catheter drainage is unsuccessful because of intolerance, urethritis, or epididymitis. Suprapubic cystotomy is also done by Vermooten for permanent drainage or for procedures on the bladder itself. Therefore he says that he is unable to compare statistics with those clinics where suprapubic drainage is done as a preliminary to either a suprapubic or perineal prostatectomy as a routine procedure. There was a 30 per cent death rate in a series of 77 suprapubic cystotomies for all conditions. Twenty-three were preliminary to perineal or suprapubic prostatectomy, with 2 deaths. Eighteen deaths followed 42 cystotomies for bladder drainage, and 3 deaths occurred after various procedures on the bladder in 12 cases. In analysis of the 21 deaths in 54 cases where no prostatectomy was done, only 1 patient was definitely shown to have perivesical suppuration at autopsy, whereas 9 ran a septic course and the rest died of metastases of carcinoma, bronchopneumonia, uræmia, etc.

There was no pelvic cellulitis in the 2 prostatectomy deaths. In 50 cases the wounds suppurred, with or without urinary leakage around the tube or through the wound.

Vermooten uses Kidd's perforator in his new procedure, and in a series of 6 cases with infected urine (in which patient was operated upon to relieve retention and not as a preliminary to prostatectomy), primary union was secured. One patient died, but his wound was clean. He exposes

¹Recent literature, particularly American literature, has repeatedly emphasized the fact that perivesical infections incidental to suprapubic cystotomy, whether done as a preliminary step to a two-stage prostatectomy or for the removal of stone, is a common occurrence. In view of the fact that my experience with this complication has been very limited, Dr. Mann has gone to the trouble of reviewing a large series of cases with autopsy reports which review gives a fair incidence of the occurrence of this complication in our material.

Whether frequency of this occurrence in the reports of other operators is due to the fact that in their attempt to drain through an opening in the bladder near its dome, the drainage tract is made high up in the abdominal wall, as illustrated in the pictures of Drs. Vermooten and Lowrey is difficult to determine. It must be self-evident that this technique which closes the wound in great part below the exit of the tubes and drains may lead to leakage of infected material into the closed perivesical space behind the sutured abdominal wall and thus favors perivesical infection with some regularity. With the technique in which the drainage tube is brought out at the lower angle of the wound, with gauze above and below it, protecting the perivesical space, no such collection of infected fluid is liable to take place, and the perivesical space is consequently protected from infection in the great majority of cases.

EDWIN BEER, M.D.

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had never been pregnant in 27 cases there was one pregnancy while in the remaining 57 cases more than one pregnancy had preceded the operation. In the 16 cases in which no pregnancy had occurred, it was impossible to establish any connection between the apparent sterility and the retrodisplacement. Several of these patients did not wish to conceive and used contraceptives. Seven were not married.

The incidence of sterility in this series of cases is therefore no greater than that found in women in general. The fact that in a certain number of cases pregnancy followed the operation does not contravert this assertion, because they were young women the sexual life had been of short duration, and the diagnosis of primary sterility was not warranted.

Similar conclusions may be drawn from the investigation of the occurrence of abortion coincidental with retrodisplacement.

In the one hundred patients of this series there were 242 pregnancies, 196 of which terminated as full term deliveries and 46 ended in abortion. There was not a single instance in which the grave condition of incarceration of the pregnant retrodisplaced uterus would have occurred although in several the patient became pregnant despite an adherent retrodisplacement. It seems that the hyperemia which attends pregnancy is capable of loosening adhesions to such a degree that the growth of the pregnant uterus is seldom affected. The incidence of abortions in this series of cases can be considered normal. Tausky estimates the number of abortions in the United States as 700,000 on the basis of a 500,000 constancy. In Germany with its accurate health statistics, the estimate is 50 per cent of abortions to the number of deliveries. In this series of retrodisplacements, the abortions amounted to 19 per cent. While it is true that accurate statistical information on the subject of abortion is impossible, yet my experience indicates that abortions occur after the correction of the retrodisplacement approximately in the same percentage as before it. This demonstrates that malposition of the uterus is very seldom a causal factor in the production of abortion.

A large number of cases operated on with good anatomical results, but without symptomatic relief raises the question: How should the indications for surgical correction of uterine retrodisplacement be formulated? In deciding this ques-

tion, the following facts are to be considered. We are concerned with an operative procedure which does not involve serious hazards, in regard to the patient's life. On the other hand, not having definite criteria prior to operation indicating which cases may be cured by surgical intervention, the operation remains an elective procedure. It is, therefore, advisable that prior to operation the following precautions be observed.

1 The patient should be subjected to a careful pre-operative study with special attention to possible extragenital pathology the symptoms of which might simulate those produced by retrodisplacement.

2 There should be a frank discussion with the patient, informing her of the possibility that the operative procedure may fail to alleviate the symptoms completely.

When a procedure of this type is undertaken, both the surgeon and patient should be prepared for possible eventual disappointment in the complete alleviation of symptoms.

CONCLUSIONS

1 The modified Gilliam operation as described is a highly satisfactory procedure, as it gives good permanent results. It should, however, not be performed as a routine measure, but modified according to the indications in each individual case. To obtain permanent fixation, the use of silk worm gut ligatures is recommended.

2 The relation of sterility and habitual abortion to retrodisplacement of the uterus is problematical. The existence of either of these conditions should not be considered as indications for ventral suspension.

3 The surgical correction of retrodisplacement is an elective procedure. Since operation does not result in the alleviation of all symptoms in every case, the patient should be so informed before the operation.

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TABLE II—CAUSES OF DEATH

Autopsied cases	Cystotomy for pro- static adenoma	For other conditions	One-stage prostatec- tomies	Two-stage prostatec- tomies
Penvesical suppura- tion	1	1	1	1
Cardiac deaths	5	4	1	3
Uremia	4	1		3
Pneumonia	3	1	2	3
Renal infection	2	1		3
Sepsis	1			3
Embolism		1		
Carcinomatosis		1		
Meningitis			1	1
Hæmorrhage				2
Totals	16	10	5	19

The autopsy reports are as follows

1 Male, aged 66 years, died August 16, 1922, after a one-stage prostatectomy. Findings gangrenous cystitis, symphysis pubis pale greenish-white, the bone being exposed and rough, yellow dirty-brown secretion in the space of Retzius

2 Male, aged 63 years, died in March, 1927, after suprapubic cystotomy to find a bladder tumor which had been seen cystoscopically, posterior to the intra-ureteric ridge, and from which punched specimens showed the tumor to be carcinoma. Findings suppuration in the perivesical space, cellulitis of the abdominal wall and the tissues about the pubis, severe cystitis and right pyelitis, purulent bronchitis, and ulcer of the duodenum.

3 Male, aged 77 years, died October, 1929. Operations left abdominal uretero-lithotomy, suprapubic cystotomy. Findings gangrenous cystitis, phlegmon of the pericystitic tissues, confluent pneumonia, adenoma of the prostate.

4 Male. Operation two-stage prostatectomy. Following removal of the packing, this patient had a severe hæmorrhage. He was re-packed, and bled again after removal of the packing. This happened a third time. Following a transfusion, he died in uræmia. Findings laceration of the bladder neck, acute cystitis, bilateral pyelonephritis.

CONCLUSION

In 8 per cent of the cases in which autopsy was done it was found that the patients died of per-

vesical suppuration in our series of cases, which does not bear out the contentions of other authors that this is the main cause of death in suprapubic cystotomy. In a series of 24 autopsies, patients on whom prostatectomy was done, only 2 died of pelvic cellulitis, which is 8.3 per cent, or 0.3 per cent of all prostatectomies. One patient of a series of 16 cases coming to autopsy in which only simple cystotomy was done for relief of obstruction due to prostatic adenoma, died of perivesical cellulitis, making a 6.2 per cent rate of mortality. Finally, 1 in 10 cases, examined after death following suprapubic cystotomy for a condition other than prostatic adenoma, died of pelvic cellulitis, making a mortality rate of 10 per cent.

We can but conclude that with proper operative technique establishing adequate drainage of the perivesical space and the wound, pelvic cellulitis or perivesical suppuration can be prevented, and is not and should not be the most dangerous complication of suprapubic cystotomy as well as the predominant cause of death.

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the bladder in the usual manner and introduces a Malecot catheter into it by means of the Kidd perforator. He sews the bladder about the catheter and according to his illustrations brings the tube out at various places, the upper angle, the lower angle, or at the middle of the wound, as the case may be. In his summary he also states that perivesical cellulitis and suppuration following suprapubic cystotomy is responsible for a large percentage of deaths, but in his series he has but one proved case to support this contention.

Lowrey and Kirwin bring the tube out at the apex of the wound, a small cigarette drain being inserted along the vesical suture line. They use the Kidd instrument and Malecot catheter, and enter the bladder at the highest point of the fundus.

This danger of perivesical infection and its attendant high mortality is not seen by us at of the Mount Sinai Hospital. We believe the technique in avoiding infection of the perivesical space with its subsequent spreading to give a pelvic cellulitis. It is practically impossible to avoid contaminating a suprapubic wound when the urine is infected. Therefore it is most important to have free and adequate drainage of the wound.

The cases under consideration were operated upon by all surgical services at Mount Sinai Hospital, and the technique was essentially the

TECHNIQUE

The bladder is well irrigated and 4 ounces of 1 per cent novocain is left in. The skin and fascia are infiltrated with one per cent novocain, and a vertical suprapubic incision is made through the skin and fascia to the perivesical fat. The bladder is distended with sterile water and the peritoneum is pushed up if necessary. The distended bladder is freed of perivesical fat in the line of incision for about 1 inch or so, and the bladder wall is infiltrated with novocain and then seized with Allis clamps, between which the incision is made into the viscous. Aspiration is used to clear the field of fluid, and the bladder is painlessly explored with the finger. A Pezzer catheter or a large tube is now introduced into the bladder and the latter is sutured with one stitch above the tube. The bladder is attached to the fascia on either side by sutured above the tube, and a strip of iodoforn gauze is inserted above and below the suprapubic tube. When the fascia is closed, no sutures are placed below the tube space sufficient for good

and adequate drainage being left. The skin is closed with a few sutures, bringing the tube and gauze drains out at the lower angle of the wound, further favoring free drainage.

With such technique we have had good results and but little suppuration, which may we repeat, result from poor drainage due to opening the space of Retzius unduly bringing the tube out of the upper limit of the wound, and by tightly suturing the fascia below the tube.

Further danger of pelvic suppuration after emuculation of the prostate may result from packing the prostatic bed too tightly causing a septic thrombosis of the veins in this region. It is our custom to pack lightly with thromboplastin gauze, and to remove this on the fourth day after operation.

Our results in a series of cases compiled from the records at Mount Sinai Hospital are shown in Table I. These patients were operated upon by several different surgeons on all surgical services from January 1914, to the present time.

TABLE I.—RESULTS AT MOUNT SINAI HOSPITAL

	Number of cases	Deaths	Per cent	Ante-mortem
Cystotomies for prostatic adenoma	58	21	36	15
Stage prostatectomy	77	7	10	5
Stage prostatectomy	518	37	7	19
Cystotomies for other conditions	8	16	80	30
Total	790	81	10	30
Suprapubic operation for prostatic adenoma	648	63	10	40

In 62 per cent of the fatal cases autopsy was done. Simple cystotomy for prostatic adenoma, with a high mortality of 36 per cent, was done for patients with acute urinary retention, many in desperate condition in uremia, cardiac collapse, etc.

In reviewing complications as cause of death, only the cases in which autopsy was done can be considered in establishing these complications as existing. At autopsy of 50 cases, the causes of death were determined as those shown in Table II.

Of the 4 patients who died of perivesical suppuration, 1 died after a one-stage prostatectomy, 1 after a two-stage prostatectomy, 1 after a suprapubic cystotomy for prostatic adenoma, and 1 after a cystotomy which was performed to find a bladder tumor.

ing After the cholesterol is extracted with suitable solvents, the analyses of the remaining pigment mixtures contained from 0.3 to 1.0 per cent copper (Schoenheimer and Herkel, 1931). Similar amounts were found in pure pigment stones without first extracting with ether. It appears, therefore, that it is the pigment fraction so common in gall stones which carries with it this hitherto unheard of concentration of copper. In addition it was shown that zinc, manganese, and iron are also concentrated in gall stones in amounts far in excess of those found in any tissues.

Further food for thought is offered by the theoretical possibility of diagnosis of gall stones by physical or electrical apparatus designed for such relatively large amounts of heavy metal. The X-ray spectroscope for instance suggests itself at once. New apparatus must be designed to overcome the difficulty of placing, in the tiny field of such optical instruments, the gall bladder the exact location of which is unknown.

Percentages of heavy metal which may be recognized in distant stars surely must be determinable two or three inches within the human skin.

EDMUND ANDREWS

CANCER THE MENACE OF REPEATED EXAMINATIONS

TWO dangers, usually though not invariably fatal in their consequences, are a constant threat in the life cycle of a carcinoma: (1) the invasion and permeation of the lymphatics, (2) the invasion of the blood stream. Clinicians in general have long recognized the importance of the permeation of lymphatics by an epithelioma and of the early spread of sarcoma through the blood stream, but less well appreciated is the invasion of the blood vessels by the epithelial and glandular cancers.

As early as 1880, Weigert by special staining methods demonstrated microscopically that cancer cells directly invade the walls of blood vessels traversing the tumor. Schmidt later amplified these studies and presented fifteen instances in which he found emboli of the cancer cell in the small pulmonary arteries without macroscopic evidence of involvement of the lung. The primary carcinoma in these cases occurred in the prostate, uterus, ovary, bladder, rectum, bile passages, and stomach.

The significance of these two studies, amply confirmed since, is obvious. Invasion of a blood vessel in the cancerous growth with subsequent metastases to the pulmonary capillaries may be present without clinical evidence. Such metastases may occur at any stage in the life cycle of the cancer, and no one can foretell or know when such a metastatic embolus is released into the blood stream. Perhaps it should be recognized that the treatment of cancer is an emergency measure almost as compelling as appendectomy for acute appendicitis, since it is fraught with even greater danger. A cancer cell, hanging on the brink of a swiftly moving blood stream, may be broken off at any moment and carried beyond reach of effective treatment. Numerous circumstances may hasten this ultimately fatal incident. Massage, the application of heat, iodine, or salves can serve only to increase the hazard of embolic metastases and to nullify completely any later attempts which may be made to control the disease.

Equally dangerous is the manipulation or handling of a malignant tumor by the examining physician. Quite unwittingly he may be party to the dissemination of the cancer by displacing cells into the lumen of an eroded blood vessel. Experimentally, Tyzzer demonstrated the evils of even gentle massage

EDITORIALS

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Associate, Editorial Staff

NOVEMBER, 1932

A CHALLENGE TO PHYSICISTS

THE presence of copper in the biliary tract has been known for many years, as it was observed very early that if the ash from gall stones was dissolved in strong acids and ammonia was added a deep blue color appeared. This fact reminded us that in the lower animals copper takes the place of iron as the heavy metal in the blood pigment (hemocyanin) and affords interesting speculations as to why it should appear with the excretory products of mammalian blood pigments.

Lack of suitable microchemical methods made further study of the problem impossible until Mallory (1921) reported experimental production of cirrhosis of the liver in animals by feeding copper. He put forth the hypothesis that this disease might be a form of chronic copper poisoning and called attention to the fact that wines and beers might be contaminated with copper either in manufacture or by the use of the vines of copper solutions as insecticides. Under this stimulus there were soon developed by Schoenheimer and Oshima (1929) chemical methods by which

such small amounts of copper as well as other heavy metals could be detected. Herkel, a pupil of the former has since published a long series of analyses, of which the following is a summary.

The normal copper content of the liver is about 25 milligrams per kilogram of dry weight. In feeding experiments irrespective of the salt fed the copper content was enormously increased. Only slight increase could be produced in any of the other tissues. The normal content of other tissues is insignificant. In pigmented cirrhosis values as high as 384 milligrams per kilogram have been found, the average being about 100 milligrams or approximately four times that found in the normal liver. However in cirrhosis not associated with pigment disposition (hemochromatosis) normal values were invariably found. This together with the fact that typical histological changes could not be produced experimentally and the fact that high values are also found in pregnancy and in infant livers, leads one to suspect that the true explanation is that copper deposit is associated with the pigment deposits and not with the cirrhotic changes.

It is also interesting to note that zinc occurs in surprisingly high concentration in the normal human liver the mean value being about 180 milligrams per kilogram. This was not increased in cirrhotic livers.

Of more special interest to the surgeon, however is a by-product of this investigation, the analyses of gall stones. Pure cholesterol stones were shown to contain no copper. However the common mixed pigment variety contained amounts which seem truly astounding.

compared to the results obtained in patients who are treated promptly after discovery of the lesion. A segregation of the two classes of patients should increase the accuracy of any statistical studies which may be undertaken to compare different methods of treatment of cancer of the breast.

EMILE HOLMAN

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SURGERY GYNECOLOGY AND OBSTETRICS

of malignant tumors grown in mice. Repeated short periods of massage of a total duration of only 3 to 5 minutes resulted in double the number of metastases outside the original tumor. Manifestly any handling and examination of a cancerous lesion, such as a lump in the breast, must be ever so gentle and brief and must be carried out by as few hands as possible.

The application of this obvious fundamental principle in the care of cancer has been conspicuously disregarded in our medical schools. One need only to follow for example, a tumor of the breast through the gantlet of examinations in the out-patient clinic at the hands of students, assistant residents and visiting surgeons, and through a second gantlet of careful hospital examinations by student, interne, and members of the house and teaching staff to realize the possible harm that can be inflicted by repeated examinations before the arrival of the patient in the operating room.

Small wonder that recent statistics from a teaching hospital (2) paint such a doleful picture and that only 12 per cent of 573 patients lived 10 years or more after the removal of the cancerous breast. On the other hand, comparable statistics from another clinic (1) where comparatively few examinations are made indicate that 13 per cent of those with axillary involvement and 44 per cent of those without axillary involvement lived 10 years or more. The wide discrepancy in results cannot properly be attributed to type of case or type of operation. The reason lies most probably in the number, vigor and trauma which are caused by repeated examinations.

Of course, it must be admitted that in any case of cancer of the breast one cannot set aside the probability that the patient herself long before admission to the hospital has been

guilty of palpation, compression, and even massage of the tumor but similar ill advised maneuvers by examining physicians cannot be too severely criticized.

To safeguard the patient and to avoid being an unwitting party to the dissemination of death dealing cancer it is suggested that teaching hospitals and clinics observe the following rules

- 1 A suspected carcinoma of the breast may be inspected but not palpated by student, interne or assistant resident except by the flat hand gently applied to the tumor which must not be squeezed or compressed by the fingers or otherwise handled.

- 2 Under no circumstances shall the glands in the axilla be felt or sought for except by the operating surgeon and then only with the gentlest touch.

- 3 The visiting surgeon or resident in charge shall determine the disposition of the case with the minimum examination possible—with inspection only whenever the eye can determine the diagnosis.

In any campaign against cancer it is essential that doctors, students, and teachers of students, should recognize the justice of these rules and that every effort should be made and every means should be employed to determine the diagnosis of accessible tumors without unnecessarily endangering the life of the patient.

Moreover it is obvious that an analysis of the results of different methods of treatment of carcinoma of the breast is incomplete and the proper evaluation of such methods practically impossible without a knowledge of what has occurred in the interval between the first recognition of trouble by the patient and her submission to medical treatment. The results in patients who submit to treatment after long delays, punctuated by massage and local remedies, cannot be



THOMAS L GILMER
1849-1931

MASTER SURGEONS OF AMERICA

THOMAS L. GILMER

A GLANCE at Dr. Gilmer's American ancestry suggests that doctors as well as poets can be born to their calling. He completed a span of two hundred years, 1731 to 1931 in which Gilmers of five consecutive generations were physicians. One George Gilmer a graduate of the University of Edinburgh, came to Williamsburg, Virginia, in 1731 after having practiced medicine for a short period in London. His son, George Gilmer II, 1743-1798 graduated in medicine at the University of Edinburgh and practiced in Virginia. His nephew John Thornton Gilmer born 1774, practiced in Georgia, and his son Frederick George Gilmer 1806-1871 graduated in medicine from the Transylvania University and was the father of Thomas L. Gilmer 1849-1931 the subject of this sketch.

The family was equally well represented in the legal profession. One George R. Gilmer was elected governor of Georgia in 1829 and Thomas W. Gilmer was elected governor of Virginia in 1840. Francis Walker Gilmer the son of George R. Gilmer became attorney general of the United States, was rated by Thomas Jefferson as the "best educated subject since the Revolution" and was sent to England by Mr. Jefferson in 1824 to procure professors for the University of Virginia.

In his life and accomplishments, Dr. Gilmer has done honor to these illustrious precedents. Born and reared in Lincoln County Missouri, he got what education he could at the public schools of that war-torn section of rural Missouri and then attended an academy at Scottville, near Springfield Illinois, where he later met Miss Ella M. Bostick, who became Mrs. Gilmore on September 29 1868. Here he also met a Dr. Bull, dentist of Alton in whose office he studied and at whose suggestion he matriculated in 1871 in the Missouri Dental College at St. Louis where he found that he was able concurrently to matriculate in the St. Louis Medical College. These co-housed institutions he attended for one term and returned to the practice of dentistry in 1871 which he again left in 1881 to obtain his degree from the Missouri Dental College, taking also his second year in medicine. In 1884 and 1885 he finished a third and final year in medicine at the Quincy Medical College at Quincy Illinois, receiving his degree and being duly licensed to practice medicine by the State of Illinois, 14 years after he first ma-

triculated in St. Louis. Such seems to have been the exigencies of self-education in the early days of the Middle West.

He accepted the appointments of oral surgeon to St. Mary's Hospital and of lecturer in microscopy and histology in the Quincy College of Medicine, which he held until he moved to Chicago in 1889. While in Quincy he became closely acquainted with the elder Black who was then engaged in constructing a major section of the foundation of modern operative dentistry, which association and friendship continued until Dr. Black's death.

In 1890, he called the meeting that organized the Northwestern University Dental School, which has become one of the largest and most outstanding dental institutions of the world, and in which he continued as the active chief of the oral surgery clinic for 40 years. The teaching of the principles of surgery to the dental students was his paramount interest, and they responded by carrying his message far and wide.

Dentistry owes Dr. Gilmer a very great debt of which it is fully conscious and is proud to acknowledge, but he was essentially a surgeon teaching surgery. His studies were along surgical lines and his concepts were surgical. In the medical school he had been under such masters as Hodgen, Johnson, and Gregory, and later he associated with the outstanding medical men of his community. He practiced oral surgery as a broad, complete specialty, and the writer believes that he has, by his observations, deductions, and constructive teachings, contributed as much to its available fund of knowledge as has any one man to any surgical specialty. His ability in this line was widely recognized and his services sought by a large and discriminating clientele and an appreciative circle of confrères.

Possibly his chief personal characteristic was an uncompromising honesty of purpose, of word, and of deed, coupled with the habit of industry, simplicity of thought, and extreme modesty. It is due partially to his modesty that his writings continued to appear almost solely in the dental literature and that relatively few in the medical profession outside of his personal acquaintances realized the extent of our indebtedness to him. Dr. Gilmer had an extraordinarily keen appreciation of the meaning of mouth pathology, yet on direct inquiry he would discuss it in but a diffident fashion and could never be induced to put his complete observations into systematic form.

It was some time in 1909 or 1910 that, in the presence of a national gathering of dental surgeons attending his clinic, he made, for him, this somewhat startling statement: "I believe every man here present is responsible for the death of one patient a year by neglecting these dental infections." When asked later if he had meant it literally, he explained that he thought the number was considerably more than one death a year for each, but that he did not like to say so. While this conclusion was based on clinical observation, he had at the time accumulated a formidable array of laboratory evidence of his own making, but to show that the

EARLY AMERICAN MEDICAL SCHOOLS

THE LAPORTE UNIVERSITY SCHOOL OF MEDICINE AND THE INDIANA MEDICAL COLLEGE

H H MARTIN, M D, LaPORTE, INDIANA

IN the early summer of 1833 John Barron Niles, who had received the degrees of A B and A M from Dartmouth College 2 years previously, and who had also been admitted to practice law at the bar of the State of New York, left his home in Vermont on horseback, hoping to reach Cincinnati, Ohio, and there make his future home.

Upon his arrival at Dayton, Ohio, over the Old National Trail, he was informed that an extensive and severe epidemic of cholera was raging in Cincinnati. For this reason he changed his plans and decided to proceed to Chicago, then having the reputation of being a rapidly growing commercial center.

In due time he passed through the little village of LaPorte, in the State of Indiana, approximately 60 miles east of Chicago. The first settlers of LaPorte, consisting of the five Andrew brothers and their associates, had arrived with their families the year before, and were making rapid progress toward developing an intellectual center in a natural setting of beautiful lakes and fertile prairie lands.

When J B Niles arrived at Chicago, he did not find the environment in keeping with his ideals. He therefore decided to return to LaPorte, where the surroundings were more to his liking. In a short time he became recognized as one of the leaders of the legal profession of the State. A man of lofty ideals and far reaching vision, Mr Niles in the year 1836 delivered a Fourth of July oration which he closed with the words

"This great valley, now sparsely populated, will soon abound with all the means of national enjoyment, will be studded with institutions of learning and temples to the living God, and will be the fairest land the sun shall ever visit in his course."

Even at this early date Mr Niles and his associates were discussing the possibility of founding an institution of higher education. In the year 1840, only 8 years after the first settler had arrived, there was granted by the legislature then in session a charter drawn by William Andrew, authorizing the establishment of the LaPorte University, to consist of a literary, a medical, and a law department.

A meeting of the organizers of the Medical Department of this University was held sometime in 1841 in the Methodist Church at LaPorte, and those present are named as Hon J B Niles, Dr J P Andrew, Dr G A Rose, Dr Franklin Hunt, and Dr Daniel Meeker. To Mr Niles must be given credit for having had the inspiration, the foresight, education, and determination to found this institution. During the years of its existence it is known he gave more than one-third of his time to its welfare.

Lectures were first delivered in February, 1842. The men who were named as organizers of the college also constituted the first faculty. Unfortunately, for 2 years there is no authentic record obtainable as to the activities or progress of this University.

In the year 1845, John B Niles states in an address delivered by him that "during the period of 5 years since the organization of this institution, its success and progress have been highly gratifying to its friends and have exceeded their most sanguine anticipations."

This session of 1845-1846 boasted a class of sixty. Some time during this year, the exact date not known, the name of the LaPorte University School of Medicine was changed to Indiana Medical College. In the year 1847, the graduating



Medical Department of LaPorte University, erected about 1840

idea was not new he produced an excerpt from a cuneiform inscription which told of a soothsayer advising his king that incantations would not cure his malady but that his majesty should have his teeth removed.

His genius was characterized by an ability to adapt simple procedures to his immediate needs his plans were direct and he was intolerant of extravagance in claim or method By combining right principles into a few simple devices he changed the treatment of jaw fractures from haphazard to exactitude. He pointed out that the displacement which so commonly rendered useless the remaining half of a surgically mutilated mandible could be prevented by temporarily wiring it to occlusion with the upper teeth. Also he early made a plea for conservatism in the treatment of certain jaw neoplasms that had commonly called for these crippling amputations. Trench mouth that "bug-bear" of the late war was no problem to his students who recognized it as Gilmer's gingivitis and knew just how to care for it and his students were not afraid to make an external incision for an abscess of dental origin. Back in the eighties we find in his writings that he was urging the dentist to associate the microscope with his practice He has done much to elucidate the pathology of chronic periodental infections and his practice of gum or of root amputation for their conservative treatment was just plain good surgery

He had a host of loving friends and he loved his friends. Nothing gave him greater pain than to find that anyone had fallen short of his estimate. His thrift did honor to his Scotch ancestors, but he was generous, good company and a real sport. He was an accomplished yachtsman was the successive owner of three fast motor cruisers, which he himself navigated, and which for years were familiar to the habitues of Lake Michigan and Lake Huron He was made a vice-commander of the Chicago Yacht Club but gave up yachting a number of years ago, ostensibly because of the expense, but it is more likely that the newly developed automobile appealed to him because of its greater speed and wider range. When past 80 years of age, he still made long solo motor trips, such as to Arizona and return.

Besides dental societies, he was a member of the American Medical Association, a fellow and a one time member of the Board of Governors of the American College of Surgeons a founder and a president of the Institute of Medicine of Chicago and, in addition to other scientific organizations, was a member of the Chicago Pathological Society

Dr Gilmer's monument is not a shaft of conspicuous personality but rather a wide field that has been fertilized to increased fruition by his endeavors.

Dr Gilmer is survived by a daughter Mrs. Virginia Gilmer Ames, also by two grandsons, Frank and Lewis Gilmer

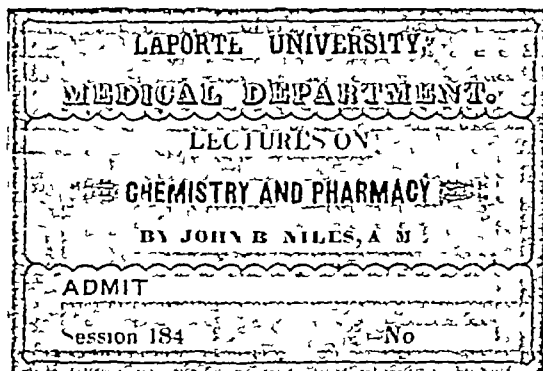
VILRAY P. BLAIR.

he resided in Nebraska, later serving with distinction with the Union troops during the Civil War.

William Andrew, who drew up the charter of the LaPorte University, organized the Law Department and was one of its instructors during the time of its existence. He later became judge of the LaPorte and St. Joseph County Circuit Court. His later years until retirement were occupied very largely as a minister of the gospel.

Dr. Zina Pitcher, who is now recognized as practically the father of the Medical Department of the University of Michigan, was a great friend of Hon. John B. Niles, and was often a guest at his home in LaPorte. In 1847, Dr. Pitcher, at the solicitation of Mr. Niles, seriously considered accepting a chair in the Indiana Medical College.

The operations performed in the medical school during the years of its existence were a credit to any school of that period. Among the operations appearing as news items in the *LaPorte County Wing* of that time we find the following mentioned and some discussed in detail. Removal of an ovarian tumor weighing forty and one-half pounds,



Admission card used by John B. Niles.

operations for congenital and senile cataracts, removal of the lower jaw of a boy of 17 years for osteosarcoma, the operation on a 9 year old child for ankylosis of the jaw, which operation was successful, the removal of a large portion of the tibia of a boy of 19 years as a result of osteomyelitis, as well as an operation for the removal of a portion of the dorsal vertebra.

Some of the patients were brought to the college from distances of over one hundred miles. That Dr. Meeker had more than a local reputation as a surgeon is indicated by the fact that he was called to the then far distant state of Iowa to remove a large tumor. The operation was successful and the patient, a woman, lived for several years.

In 1832, there came to LaPorte on horseback with other members of her family a little girl of three, Catherine Andrew. Later she became the wife of her cousin George Andrew, one of the graduates and later professors of the Indiana Medical College. In the year 1847, after reading an account of the demonstration of the administration of ether in the Massachusetts General Hospital the previous year, Dr. George Andrew took a picture of the mask used to a local tinsmith, who reproduced one of like design. When his wife was giving birth to their first child, Dr. Andrew administered ether to relieve the pain. There is little doubt that this is the first instance in which ether was used for this particular purpose.

Considering the time, location, and transportation facilities, the LaPorte University and the Indiana Medical College should be given a much more prominent place in the history of medicine of the Middle West than they now occupy.



Members of the faculty of LaPorte University 1, Daniel Meeker, 2, John B. Niles, 3, Jacob P. Andrew, 4, George W. Richards, 5, J. Adams Allen, 6, Tompkins Higday

class of the Indiana Medical College consisted of twenty-seven members, from the states of New York, Wisconsin, Michigan, Illinois, and Indiana. During this session there were one hundred and four matriculates and nineteen graduates.

So rapidly had the college expanded, and so bright were its prospects that in 1847 it was found necessary to increase its facilities. In consequence a city block was purchased whereon was erected a building planned to accommodate from two hundred and fifty to three hundred students. It contained two large lecture rooms in amphitheater form, a dissecting room in circular form, also two large rooms for museums, and private rooms for the professors. It was reported to be one of the best arranged college buildings in the west, and was first used in November 1847. After the erection of the new building, the old medical building was taken over by the Northwestern Academy of the Natural and Medical Sciences of Chicago.

In February 1848, the annual commencement of the Indiana Medical College was held and 37 men were graduated. In addition one man was admitted as an honorary member of the institution and 3 received the honorary degree of M.D.

During the session of 1848-1849 one hundred and one students were reported in attendance. The Indiana Medical College continued to operate during the season of 1849-1850. The annual commencement was held on Thursday evening, February 24, 1850. Another session was held during the winter of 1850-1851.

The *LaPorte County Whig* of May 21, 1851, quoting from the *Indiana Journal*, makes the announcement that the Indiana Medical College at LaPorte, Indiana, had consolidated with the Indiana Central Medical College, which at that time was a department of the Indiana Asbury University located at Greencastle, now known as the DePauw University. For many years it was not known why the Indiana Medical College went out of existence, but after reviewing many old documents, we are forced to the conclusion that its discontinuance was due to discord and the development of factions among the faculty.

In January 1856, the main medical building, which had been erected in 1847 and which was

prized so highly, was destroyed by fire, and with it all the records of the LaPorte University and the Indiana Medical College. The microscope,

which was the pride of the institution and which undoubtedly was the first to be used extensively for scientific purposes west of Cleveland, a large number of teaching charts, some of which had been imported from London, and all specimens in the museum were also destroyed.

At various times there was connected with the institution a number of men then prominent in medical circles or who were to become outstanding in later years. A news item appearing in the *Detroit Free Press* during the winter of 1850 indicates that Dr. Samuel Denton and Dr. J. Adams Allen had accepted chairs in the newly organized medical department of the University of

Michigan. Both of these men at one time were members of the faculty of the Indiana Medical College.

Dr. Daniel Meeker, who came to LaPorte in the year 1833, soon became known as a skillful physician who had more than average natural ability as a surgeon. After the consolidation of the Indiana Medical College with the Indiana Central Medical College, Dr. Meeker taught for 3 years in the Medical Department of the University of Iowa, then located at Keokuk. He served one year as president of the Indiana State Medical Association.

Dr. E. Deming, who came to the college in 1847 as professor of theory and practice, was later preceptor for W. W. Mayo, Sr. At one time Dr. Deming lost the presidency of the University of Michigan by but two votes. He ran for governor of the State of Indiana, but was defeated because of his profound Abolitionist convictions. Dr. Deming later became associated with a medical school at St. Louis, Missouri, and died in 1853. He also served one year as president of the Indiana State Medical Association.

Dr. Jacob Andrew was educated as a minister and was a circuit rider in the hills of Kentucky until his health failed him, forcing him to give up his efforts in this field. Thereupon he studied medicine and was graduated from the Cincinnati Medical College. After the LaPorte school closed



John B. Niles, A.B. A.M.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

IN a very brief way, many of the salient points and much of the literature on the problem of "Chronic Myocarditis" is presented by Sutton and Lueth in their book¹ recently published. The authors use the term chronic myocarditis synonymously with arteriosclerosis of the heart. Their discussion is divided into symptomatology, anatomy, pathology, physiology, pharmacology, and treatment. The symptoms of fatigue and extrasystoles are emphasized. The authors' experimental observations showed that narrowing the lumen of the coronary arteries produced pain in the dog which varied in intensity with the degree of obstruction and the size of the vessel. Removal of the stellate ganglion completely abolished pain while the cutting of the vagi had no effect. Muscle destruction produced no pain. The nerve supply to the heart is well discussed. The pharmacology of the various coronary dilators is discussed and the increase of coronary circulation of 42 to 47 per cent by the purine bases is reviewed. The rôle of diastolic blood pressure and coronary blood flow is discussed. A caution is voiced on the dangers of lowering the blood pressure. Emphasis is placed on full therapeutic doses of morphine, digitalis, and theobromine in the management of chronic myocarditis.

M. HERBERT BARKER.

CUTTING modestly has prefaced his book² with the following quotation from Montaigne "I have gathered a bouquet of other people's flowers and only the thread that holds them together is my own." But to Cutting goes the high credit of selecting only the finest flowers and arranging them in the most attractive manner. The reviewer considers this book to be a contribution of utmost importance, a most scholarly and judicious presentation of the best thought on perhaps the most important phase of surgery. Matas, in his stimulating foreword, says, "there is no better test of good surgical generalship than that afforded by the conduct of the attending surgeon in the presence of an unexpected and menacing postoperative complication." Cutting not only gives detailed guidance in postoperative treatment and complications but also in pre-operative preparation and the estimation of surgical risks.

¹ DISEASES OF THE CORONARY ARTERIES (MYOCARDITIS). By Don C. Sutton, M.S., M.D., and Harold Lueth, Ph.D., M.D. St. Louis: The C. V. Mosby Company, 1932.

² HOEBER'S SURGICAL MONOGRAPHS. PRINCIPLES OF PRE-OPERATIVE AND POSTOPERATIVE TREATMENT. By Reginald Alexis Cutting, M.D., C.M., M.A., Ph.D. Foreword by Rudolph Matas. New York: Paul B. Hoeber, Inc., 1932.

The volume is rich in good things but especial credit should be accorded to the chapters on blood transfusion, water balance, and disturbances of acid-base equilibrium. Dilatation of the stomach, urinary disturbances, abdominal distention, and postoperative pulmonary complications are fully considered. Special chapters are devoted to the pre-operative and postoperative care of diabetics, gall-bladder cases, toxic goiter patients, gastric cases, intestinal obstruction, burns, etc. The references are numerous, valuable, and up-to-date.

Every surgeon may read this book with profit but it will be of especial value to internes and residents.

FREDERICK CHRISTOPHER

IN a short treatise³ Dr. Frühwald describes his methods of performing cosmetic operations on the nose and ear and for the removal of wrinkles and folds from the face. There are 80 pages of text and 88 illustrations. The author states that the book was written because it might be of value in helping to refresh the memory of those doctors who have done practical work with him. The author stresses the point that it is impossible to acquire a knowledge of plastic surgery from this book, because, as in the whole field of surgery, book work alone is insufficient. However, he hopes that all expectations in the scientific study of plastic surgery will be fulfilled. Plastic surgery is said to be a new science dating from 1856. No photographs of patients are shown because they are of no particular use to the reader, and because, after operation, pictures may be erroneous. Anatomy occupies one page with one side illustration of the nasal cartilages.

Preparation for plastic operations includes care of the area and the suggestion that the patient bring two photos of himself for trimming and comparison. No mention is made of pre-operative casts or patterns.

For bony humps the rasp is used, for saddle nose, ivory implants are recommended. The operation is said to be very difficult, and one to three operations may be necessary. A paraffin injection syringe is shown but the method is not recommended.

Operations on the cartilaginous nose are said to be easy and are always done under local anaesthesia. Here second operations are even more apt to be necessary.

³ PLASTIC SURGERY OF THE NOSE, EAR, AND FACE. By Victor Frühwald, M.D. Translated by Geoffrey Morey, M.B., B.S. (Adelaide). D.O. (London). Vienna: Wilhelm Maudrich 1932.

CORRESPONDENCE

THE IMPORTANCE OF THE TRAINED RADIOLOGIST IN EVERY CANCER CLINIC

To the Editor: With few exceptions cancer students throughout the world accept radium as the means of choice in the treatment of cancer of the cervix, skin, and mouth. In the very earliest stages of the disease, when the lesion is no larger than any local lesion not cancer the most economical treatment is removal with a knife, electric needle, or electric cautery. However when the microscope shows that the growth is definitely cancer the treatment should be radium. As we educate people to the value of having periodic health examinations and of reporting to their physicians the moment they observe anything unusual, and when the childbearing woman learns the value of periodic pelvic examination, there will be an increasing number of patients afflicted with cancer of the skin, mouth, and cervix who will be treated with radium administered in relatively small amounts, and the results thus obtained will depend entirely upon the training of the radiologist. It does not make any difference to what other department of medicine the radiologist belongs, be or she must have proper preliminary training and experience in the application of some form of radium to the cancer area in the skin, mouth, and cervix, to get the best results.

A most difficult task of the American College of Surgeons is to provide the cancer clinics of standard hospitals with trained radiologists. It may be necessary for the hospital or the medical staff of the cancer clinic to finance the proper training of one of their members as a radiologist. At the present time it seems that the greatest good in controlling cancer will be accomplished by putting the radiologist on a full time salary and let him work with all the clinical specialists, pathologists, surgeons, and internists. At the present moment too many physicians not properly trained are using radium. The radiologist must be a trained pathologist or must be associated with a trained pathologist, because an essential feature in the cure of cancer is the recognition of its presence by means of microscopic

examination of tissue. A thorough knowledge of the location of the growth is also essential and for this reason a trained gynecologist should help the radiologist and pathologist in diagnosing and treating cancer of the cervix, a trained oral surgeon in diagnosing and treating cancer of the mouth, and a dermatologist of experience should work with the radiologist and pathologist in the diagnosing and treatment of cancer of the skin. With rare exceptions, the approved hospitals have all of the essential personnel and equipment except perhaps the radiologist, and in some instances radium, although the necessary amount of radium can usually be provided in most of the hospitals which have been approved.

It is true that even in the best organized cancer clinics with their expert radiologist, pathologist, surgeon, and internist, and with the best equipment, there will result many failures, for many patients come too late in the progress of the disease to be cured and treatment can then at the most be only palliative. And so we emphasize the necessity for each approved hospital doing its part with the county medical society and the health department in educating the people to seek the advice of their family physicians and to have periodic examinations. For those who cannot afford to consult the family physician there should be provided clinics in hospitals and dispensaries where the necessary examinations can be made in co-operation with the medical profession of the community.

Let me repeat that there should be kept in mind two important factors in the further control of cancer namely (1) the need of a trained radiologist in every cancer clinic and (2) the provision in each locality for the education of the public in addition to the provision for diagnostic clinics where physical examinations can be made with the co-operation and under the control of the entire medical profession and health departments.

JOSEPH C. BROOKHOFF.
Baltimore.

fail to find specific advice, and will be forced to consult special monographs. Our present state of knowledge upon the subject of radiotherapy renders a permanent statement on these matters exceedingly difficult, and the author has perhaps wisely adhered to the principles of treatment and relegated to special treatises the still controversial field of specific surgical and radiotherapeutic indications.

In an opening discussion of precancerous lesions the author soundly defends the use of the term "precancerous" by correcting the impression that a progressive sequence of events is inevitable and pointing out that the term simply indicates a condition which may be associated with the development of cancer.

In an otherwise completely up-to-date chapter upon cancer of the oral cavity the author states that the lympho-epithelioma of the oropharynx are treated by irradiation with local success but without preventing the eventual fatal outcome. Recent developments require a qualification of this statement. Possibly when this was written the results of Coutard and of Beren had not been published reporting a small but definite percentage of 5 year cures of these lesions treated by an improved technique of roentgen radiation and distance radium therapy.

The chapter on cancer of the mammary gland contains much useful information. However, the statement that chronic mastitis is frequently associated with cancer will add to the existing confusion upon this controversy. On this point the author is subject to the criticism of retaining a too well established term to designate a group of conditions totally unrelated, some innocent and physiological and certainly unrelated to cancer, others serious and pathological and certainly related to cancer. With the position that an intimate relation exists between hyperplastic, cystic, and papillomatous states and cancer of the breast, the author will find almost universal accord. With the suggestion that a chronic inflammation is a predecessor to cancer of the breast he may find less general agreement.

A detailed and comprehensive discussion of the microscopical cellular pathology, modes of extension and metastasis, clinical manifestations, prognoses, and treatment of breast cancer follow and complete this important chapter, which concludes with a well chosen bibliography.

The chapters on cancer of the gastro-intestinal tract and uterus are complete, comprehensive, and well illustrated. The high power photomicrographs are well selected, unusually clear, and effectively reproduced.

In a single volume upon the entire subject of cancer the reader can neither hope nor expect to find a historically complete and comprehensive survey of all phases of neoplasms. For such details he must consult the special monographs. Indeed, it is in the wise selection of the most important and practical data to the exclusion of the less significant details that the author has displayed sound judg-

ment. For a general survey of the essential etiological, pathological, and clinical manifestations of cancer affecting various organs the physician will find in this volume a useful treatise. The author is to be congratulated upon the results of his efforts.

MAX CUTLER.

THE small volume on *Puerperal Infection*¹ fulfills the purpose of the author in that the student will receive a complete view of the subject, the practitioner will be delighted with the practical and concise presentation, and the specialist will be interested in a review of our knowledge of and the author's views upon puerperal infection.

The arrangement of the chapters is orderly, beginning with a short history, then etiology, pathology, symptomatology, diagnosis, prognosis, and treatment. There is also a short chapter on breast infections during lactation. In order to present an uninterrupted exposition, Goodall avoids all references in the text but lists them at the end of the book. His views are based on "twenty-eight years of clinical experience and enquiry." At times these views are expressed with conviction, without experimental proof which may or may not substantiate them.

The bacteriology of the usual infections is described but that of the serious ones which occasionally occur, as *Bacillus diphtheria*, *Bacillus welchii*, and various mixed infections is lacking.

The importance of immunity and predisposition is well stressed. An exposition on the reticulo-endothelial system should not have been left out of this chapter, especially since Goodall presents puerperal infection as a general and not a local infection.

The pathology follows in a logical classification of the lesions produced, dependent on the mode of extension.

In the symptomatology, Goodall sets the following standard for morbidity: any case that has a temperature of 99 degrees, or more, for 3 consecutive days, exclusive of the first 24 hours postpartum, is a morbid case. This point is debatable and can hardly be discussed in a brief review. He also states that 80 per cent of the cases of puerperal infection are symptom-free. Later evidence of this is endocervicitis in 60 to 70 per cent of postpartum patients. The usual clinical pictures are presented and the symptoms are correlated with the pathology.

It is, indeed, with deep reverence that the young man bows to the old clinician when he makes a prognosis in a puerperal infection on the faces, pulse rate, and temperature. He also considers such determining findings as a hemorrhagic state, biochemical tests, and blood cultures.

The chapter on treatment is very interesting and is very expressive of certain conditions present in the profession. For instance "most of the misad-

¹PUERPERAL INFECTION. By James Robert Goodall O.B.E., B.A., M.D., C.M., D.Sc. Toronto, Canada: Murray Printing Co., Ltd., 1932.

Reduction in size or of prominence of the ear is discussed in 13 pages. The last 13 pages are given to diagrams and descriptions of removing wrinkles and folds from the face.

No mention is made of skin grafts, flaps, total or partial nose, ear or face reconstructions, tumors, rhinophyma, ptosis, seventh nerve paralysis, hare-lip, or other marked congenital deformities.

JAMES HARRERT BROWN

AS the authors state the main purpose of their book on *Diseases of the Kidney*¹ is to give an account of kidney disease from the viewpoint of a physician and surgeon in close collaboration. I commend the book by Ball and Evans to both physicians and surgeons, knowing that a thorough knowledge of its subject matter may develop the means of furthering a mutual co-operation in the management of all types of renal disorder.

The presentation is simple, direct, and practical. The methods of approach in clinical diagnosis are stressed and all modern methods of examination, biochemical and instrumental, are fully described. The so called medical and surgical diseases of the kidney are considered together in a clear and logical manner. Particular attention is given to cystoscopy, ureteral catheterization, radiography and pyelography. The work is amply illustrated with excellent drawings, photographs, and roentgenograms.

VICTOR J. O'CONNOR.

MODERN medicine is so replete with technical expressions that even the highly intelligent reader demands the aid of a dictionary. To facilitate the necessary reading, interpretation, and translation of the German medical literature a new edition of Lang's well known work² has appeared.

No dictionary can ever be absolutely complete, because new terms appear almost daily. When a revision of an already existing work becomes necessary the current literature must be thoroughly scanned for new words.

This new edition shows a laudable improvement in some respects. New words have been added, many of them medical, many botanical. A new feature is the pronunciation, which is detailed and lengthy and accounts for most of the 900 pages by which the book has been enlarged. The value of this to the American reader remains doubtful. In the definitions themselves few changes are apparent, although some were lacking in clearness and exactness.

J. DANIEL WILLIAMS.

BOAS and Goldschmidt in a 166 page monograph³ have written up their extensive studies of the

heart rate under physiological conditions and a lesser number under pathological conditions, including anesthesia and operative procedures, organic and functional heart disease. The studies were made with an instrument known as the cardiographometer which is fastened to the chest wall with two electrodes over the precordium. The record is transcribed on a moving paper tape.

Studies were made during waking and sleeping hours under a variety of physiological states, including ingestion of food, physical exercise, sexual activity, emotional and mental stress. The heart rate was also studied on a series of patients under different anesthesia and during operative procedures. A relatively small number of patients were studied with cardiac diagnoses listed as: cardiac insufficiency, valvular disease, myocarditis, Grave's disease, neurogenic sinus tachycardia, arrhythmic fibrillation, and heart block.

The methods and character of records on the physiological variations of the pulse are accurately done. The same applies to the anesthetic and operative studies. The studies made on cardiac disease were insufficient in number to warrant any accurate conclusions.

This book represents a vast amount of work on heart rate, defining the physiological facts. It is questionable if the energy and the time expended in this was worthy of the information secured.

C. C. MARRAS.

VARIED and peculiar difficulties promptly beset the author who attempts to present the complex and complete subject of human cancer in the concentrated form of a single volume. Thus separate monographs upon special phases of cancer are becoming more and more popular. In Stout's work, however, the author has succeeded admirably in overcoming many of these difficulties.

An accurate presentation of the clinical picture of neoplasms by one intimately familiar with the surgical pathology of tumors constitutes perhaps the most valuable phase of this work. For lack of space the author purposely has omitted historical surveys and instead has filled his limited pages with much practical and useful pathological and clinical data.

The arrangement of the book is attractive, and the description of neoplasms according to anatomical site will prove to be a practical convenience. Throughout these pages the reader detects the broad knowledge and experience of the author with the pathological and clinical manifestations of neoplastic disease.

If there is any fault to be found with the work, it is on the important subject of treatment. Upon the ever present question of the choice between radiation and surgery their single and combined indications and contra-indications, the reader will

REFERENCED: ¹EDWARD BALL and EDWARD EVANS, *Physiology and Pathology of the Kidney*. Philadelphia: P. Blakiston's Son & Co. Inc., 1934. ²LANG'S *GERMAN-ENGLISH DICTIONARY OF TERMS USED IN MEDICINE AND THE ALLIED SCIENCES WITH THEIR SYNONYMS*. Revised and edited by ARTHUR K. MAYER, M.D. 2d ed. Philadelphia: P. Blakiston's Son & Co. Inc. ³BOAS and GOLDSCHMIDT, *By Ernest F. Boas, M.D. and Ernest F. Goldschmidt, Ph.D.* Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1932.

¹EDWARD BALL and EDWARD EVANS, *Physiology and Pathology of the Kidney*. Philadelphia: P. Blakiston's Son & Co. Inc., 1934.

²LANG'S *GERMAN-ENGLISH DICTIONARY OF TERMS USED IN MEDICINE AND THE ALLIED SCIENCES WITH THEIR SYNONYMS*. Revised and edited by ARTHUR K. MAYER, M.D. 2d ed. Philadelphia: P. Blakiston's Son & Co. Inc.

³BY ERNEST F. BOAS, M.D. and ERNEST F. GOLDSCHMIDT, Ph.D. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1932.

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UNILATERAL EXOPHTHALMOS IN INTRACRANIAL TUMORS WITH SPECIAL REFERENCE TO ITS OCCURRENCE IN THE MENINGIOMATA¹

CHARLES A. ELSBERG, M.D., F.A.C.S., CLARENCE C. HARE, M.D., AND CORNELIUS G. DYKE, M.D.,
NEW YORK

IT is well known that protrusion of *both* eyeballs occurs in tumors and inflammatory processes in the orbital cavities, in exophthalmic goiter, and in increase of intracranial pressure due to chronic hydrocephalus, neoplastic inflammatory or vascular lesions within the cranial cavity, and in a number of other pathological conditions.

Unilateral exophthalmos occurs in new-growths and inflammatory processes in one orbit, in paralyzes of the ocular muscles of one side, and in affections of the large intracranial blood vessels—including arterial and arteriovenous angiomas, thrombosis of the cavernous sinus, and aneurismal communications between the internal carotid artery and the cavernous sinus (pulsating exophthalmos).

In this report we shall limit ourselves to the consideration of a series of cases in which a *unilateral* exophthalmos was caused by a new-growth within the cranial cavity, and in which for a long period, the protrusion of the eyeball was the outstanding or the only disturbance.

LITERATURE

In 1887, Durante published the report of a case of meningeal tumor in the anterior cranial fossa, which had caused mental changes, unilateral exophthalmos, and loss of the sense of smell. The cribriform plate of the ethmoid was destroyed on the same side and the roof of the orbit was depressed. Five years later,

E. Mueller published the results of a study of 168 cases of frontal lobe tumor. Three of the patients had protrusion of the eyeball on the side of the lesion, and in a fourth the protrusion was bilateral. This author expressed the belief that in tumors in the anterior cranial fossa the exophthalmos may be the result of erosion of bone and extension of the neoplasm into the orbital cavity, of paralysis of the muscles that move the eyeball, or of circulatory disturbances.

Flatau in 1903, contributed a very interesting paper on the connection between exophthalmos and intracranial pressure, based upon 10 cases collected from the literature and 5 that he had personally observed. The protrusion of the eyeballs was bilateral in 14 of the patients although one eyeball was sometimes more prominent than the other. In a case of tumor of the pons, there was a unilateral exophthalmos. The cases included tumors in different parts of the cranial cavity, brain abscess, meningitis, and hydrocephalus, and in all there was an increase of intracranial pressure. Flatau believes that the chief factor in the production of the exophthalmos was increased intracranial pressure and interference with the return venous flow from the orbits. According to this author, pressure on the dural sinuses in any part of the cranial cavity may result in stagnation of blood in the cavernous sinus, venous congestion within

¹Read in part, at a meeting of the Section on Ophthalmology of the New York Academy of Medicine, April 18, 1932.

ventures of today do not arise so much from errors in surgical technique as from errors in obstetrical judgment," may be applied to those versed in surgery attempting obstetrical problems. He makes an excellent point in stating that vaginal examination must be done when there is any doubt about the rectal examination. Also, he emphasizes the importance of avoiding long labors in the absence of progress as a common cause of infection.

His generalizations about specific therapy are not in agreement with other workers. Here again the importance of bacteriological and clinical, pathological diagnosis is not mentioned as the logical guide for treatment. In 1932, in speaking of serum-therapy he states that "In others (Institutions) it is occasionally used when all other means have failed to give results." It is surprising to think that miracles are still expected at this time. The life

saving importance of serum for gas bacillus and diphtheria is overlooked. The recent work on puerperal sepsis streptococcal antitoxic serum has not been seen apparently. The importance of glucose and blood intravenous therapy is very well emphasized.

A. F. LANE.

IN this first volume¹ Cadenat has given us an excellent surgical anatomy of the upper extremity. The various incisions and the successive steps in the dissections necessary to expose all of the important structures are carefully described in the text and beautifully depicted by original illustrations. The section dealing with the incisions for hand infections profitably could be enlarged and better illustrated.

FREDERICK CROOKSHANK.

LES VUES DE PÉRIOSTÉOTOMIE SUR MEMBRE. Tome I, Membre Supérieur. By F. M. Cadenat. Paris: G. Doin & Co, 1931.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

THE PSYCHOLOGICAL EFFECTS OF ALIMENTATION. By Mary Chadwick. New York and Washington: Nervous and Mental Disease Publishing Company, 1932.

CEREBRAL LESIONS IN NEW BORN CHILDREN CORRELATIVE OF BRAIN TRAUMA; WITH AN INQUIRY INTO THE NORMAL AND PATHOLOGICAL ANATOMY OF THE NEOCORTEX. By Erik Rydberg. Copenhagen: Levin & Munksgaard, 1932.

PHARMACOLOGY OF THE MEDICINAL AGENTS IN COMMON USE. By Stanley Collier, Ph.D., Sc.D. Indianapolis, Indiana: E. H. Lipp and Company, 1932.

THE CARDIAC OUTPUT OF MAN IN HEALTH AND DISEASE. By Arthur Groffman, Ph.D., M.D. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1932.

LA PRATIQUE CHIRURGICALE ILLUSTRÉE. By Victor Paschot. Vol. XVII. Paris: G. Doin & Co, 1932.

TREATMENT OF SYMPHYSIS. By Jay F. Schenck, A.B., M.D. and Carroll S. Wright, B.Sc., M.D. New York and London: D. Appleton and Company, 1932.

THE HOW AND WHY OF LIFE. By Emma Wheat Gillmore, M.D. New York: Livright Inc., 1932.

ENDOCRINE MEASURES. By William Engelbach, M.D., F.A.C.P., B.S., M.B., D.Sc. With a Foreword by Leoline F. Barker. Vol. I, General Considerations; vol. II, The Infantile Endocrinopathies. The Juvenile Endocrinopathies vol. III, The Adolescent Endocrinopathies. The Adult Endocrinopathies. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1932.

EXCITABILITY A CARDIAC STUDY. By W. Burridge, D.M., M.A., Oxon. London: Oxford University Press, 1932.

A NEW PHYSIOLOGY OF REGULATION BASED ON A STUDY OF CARDIAC ACTION. By W. Burridge, D.M., M.A. London: Oxford University Press, 1932.

BIRTH, STILLBIRTH, AND INFANT MORTALITY STATISTICS FOR THE BIRTH REGISTRATION AREA OF THE UNITED STATES 1929. Fifteenth Annual Report. U. S. Department of Commerce. Washington: U. S. Government Printing Office, 1932.

TRANSACTIONS OF THE AMERICAN PROCTOLOGICAL SOCIETY, Thirty Third Annual Session Held in Memphis, Tennessee, May 6 and 7, 1932. Birmingham, Alabama: American Printing Company, 1932.

This survey of the literature shows that all of the authors agree that an increase of intracranial pressure may produce exophthalmos, which may be unilateral or bilateral. We suspect that in many of the patients in whom a prominence of only one eyeball was believed to be the result of a general increase of intracranial pressure, careful exophthalmometric measurements might have shown that there was also some protrusion of the other globe. In our series of brain tumors, slight bilateral exophthalmos was not very rare, especially if for a long period there had been a dilatation of the third as well as of the lateral ventricles. Slight protrusion of one or of both eyeballs would probably be a frequent finding if measurements were made as a routine.

The writers who discuss the subject of etiology believe that when the intracranial disease has not directly invaded the orbital cavity, venous stasis is an important factor in the production of exophthalmos, and that, in intracranial tumors, the neoplasm may make direct pressure upon the cavernous sinus or upon the ophthalmic vein with a resulting venous stasis and increased prominence of one or both eyeballs. Most writers also state that in intracranial expanding lesions, some degree of proptosis may be due to paralysis of the ocular muscles as the result of interference with their nerve supply. As is well known, the eyeball is to some extent held in position by the four rectus muscles, while the two oblique muscles, if unopposed, rotate the eyeball and pull it forward. Therefore, if some of the ocular muscles were affected, the action of other muscles might cause a certain amount of protrusion of the globe. It must be rare, however, when there is pressure upon them or their nerve supply in the middle cranial fossa, that some muscles are paralyzed and others not.

To what extent, if at all, a disturbance of the sympathetic nerve supply to the eyeball may have etiological significance is, as yet, undecided. It is well known that a lesion of the cervical sympathetic or removal of the cervical sympathetic or of the stellate ganglion will produce enophthalmos, but it does not follow that irritation of these structures will produce the opposite condition, i.e., increased prominence of the eyeball.



Fig. 1. Case 1. Appearance of the patient before operation and after operation.

From our own experiences it is probable that distinctly unilateral exophthalmos in tumors within the cranial cavity, is most often produced by direct encroachment of a neoplasm or bone disease upon the contents of the orbital cavity or pressure transmitted to the orbit through the superior orbital fissure. It may be that direct pressure upon the large vessels through which the venous blood from the orbit and the eyeball is carried is a contributing factor.

THE FREQUENCY OF UNILATERAL EXOPHTHALMOS IN A SERIES OF INTRACRANIAL TUMORS

In our series of 807 cases of verified intracranial neoplasm (up to December 1, 1931) marked protrusion of one eyeball occurred in 15 patients, or in 1.9 per cent.

In 139 patients of this series the new-growth was situated on one or on both sides of the anterior cranial fossa or in the anterior part of the middle fossa, and among these unilateral exophthalmos occurred in 15, or in 10.8 per cent. Sixty-one of the 139 patients had meningiomas and in 10 of these there was a protrusion of one eyeball (16 per cent). As there were 10 meningeal tumors among the 15 cases of growths with unilateral exophthalmos, the incidence, in this respect, was 66 per cent.

The meningiomas (and the cranial hyperostoses which occur in these growths) are a frequent cause of protrusion of *one* eyeball. Slight prominence of *both* eyeballs was noted

the orbital cavity and exophthalmos. A disturbance of the sympathetic control of the blood vessels as a result of the increased pressure may also play a rôle. Unverricht attempted to determine whether in this respect the autonomic nervous system was of importance, but he failed to produce exophthalmos by faradic stimulation of the cervical sympathetic.

Rosenblath studied the previously reported cases of protrusion of the eyeballs secondary to intracranial tumors, and described a case of glioma of one frontal lobe in which bilateral exophthalmos occurred, and in which at the autopsy the orbital cavities were found to be free of tumor tissue. He believes with Flatau that stagnation of blood (and venous congestion) is a frequent cause of the proptosis.

In his textbook on tumors of the nervous system Bruns states that growths in the middle cranial fossa may extend into the orbit through the superior orbital fissure with, sooner or later, exophthalmos and ophthalmoplegia. In 1910, Weisenburg took up the study of the subject, collected 34 cases from the literature, and reported 8 cases of his own. In 5 of his cases, the protrusion was bilateral and in 3 unilateral. In hydrocephalus due to tumor the exophthalmos is apt to be bilateral, and in unilateral growths, only one eyeball may be affected. In his own patients unilateral ocular protrusion occurred in a patient with a third ventricle tumor. In one with a growth in the middle cranial fossa, and in a third, after operation, in a case of a growth in the brain stem and the cerebellar hemispheres. Weisenburg believes that interference with the venous flow through the cavernous sinus either directly by the pressure of a neoplasm or indirectly as the result of a high degree of intracranial pressure is a frequent cause of increasing prominence of one or both eyeballs.

Cushing (3) in a paper on the cranial hyperostoses produced by meningeal growths, refers to one case of meningioma in the middle fossa in which protrusion of the eyeball of the same side had existed for 10 years, and states that in most of the meningeal growths in this situation with an associated hyperostosis, there is an exophthalmos on the same side.

In a report upon the orbito-ethmoidal osteomata having intracranial complications, Cushing (4) described 3 cases in which unilateral exophthalmos occurred. This paper was soon followed by one by Benedict, in which 3 similar cases were described. Five cases of unilateral exophthalmos were reported by Houser 1 of which was due to intracranial tumor 1 to cavernous sinus thrombosis, a third due to arteriovenous aneurism of the internal carotid artery and the cavernous sinus and 3 due to disease within the orbit. Three causes of protrusion of one eyeball are mentioned: lesions within the orbital cavity; stagnation in the orbital veins; and paralysis of the orbital muscles. McLaurin in a paper on unilateral exophthalmos, states that a variety of cranial and intracranial lesions may produce the condition and he refers especially to hydrocephalus and to oxycephaly.

In Puusepp's monograph on tumors of the brain 3 cases of protrusion of the eyeball are mentioned. In 1 of 16 patients with frontal lobe tumors there was unilateral exophthalmos, and in this case the growth had perforated the roof of the orbit and had invaded the orbital cavity. Among 6 cases of tumors of the temporal lobe there was protrusion of the eyeball on the same side as the neoplasm in 1 patient.

In the monograph of Cushing and Bailey on tumors arising from the blood vessels of the brain, there are clinical records of 3 patients in whom unilateral exophthalmos was observed and of 3 others in whom there was a bilateral protrusion of the eyeballs. In the latter the eyeball on the side of the intracranial lesion was the more prominent of the two. These 4 cases occurred among 12 cases of supratentorial venous and arteriovenous angiomata.

The latest report on the subject of exophthalmos complicating intracranial lesions was found in a paper by Rowland on the so called Christian syndrome. In 15 cases of this disease in which exophthalmos was observed, the protrusion of the eyeballs was bilateral in 10 and unilateral in 5 patients. In all, the protrusion of one or both eyeballs was due to extension of the disease from the cranial into the orbital cavity.

and in orbito-ethmoidal osteomata There is no reason why protrusion of an eyeball may not occur in other types of intracranial new-growth It is certainly not so very rare in metastatic disease of the bones of the skull with intracranial complications and in arterial and arteriovenous angiomas In the malformations of the cerebral blood vessels, however, the exophthalmos is usually bilateral, although one eyeball may be more prominent than the other

THE SITUATION OF THE LESION WHICH PRODUCES THE EXOPHTHALMOS

The protrusion of the eyeball was on the left side in 9, and on the right side in 6 of the 15 patients Eight were females, and 7 were males The lesion was on the left side in 7 of the 8 females, and on the right side in 5 of the 7 males This *predilection for the left side in females, and for the right side in males* is of interest In the literature, the cases in men of unilateral exophthalmos due to an intracranial lesion most often occurred on the right side

As has been mentioned in an earlier part of this report, in all of our patients the growths lay in the anterior or the middle cranial fossa, or in both In most of the instances in the literature and in all of our cases in which the tumor was limited to the anterior cranial fossa, there were either marked bony changes or the growth had perforated into and occupied space in the orbital cavity This fact is, of course, easy to understand A tumor which does not extend beyond the limits of the anterior cranial fossa and which has not eroded or produced some other change in the roof or walls of the orbit, or which has not caused a localized increase of pressure in the homolateral middle fossa, can not cause a dislocation of the

orbital contents The veins which drain the orbit the muscles which move the eyeballs, and the nerves which innervate the ocular muscles lie in the middle cranial fossa, and they would not be involved by a neoplasm in the anterior cranial fossa unless it had encroached upon or had caused a localized increase of pressure in the middle cranial fossa

Theoretically tumors in and around the temporal lobe in the middle cranial fossa may make pressure upon the cavernous sinus, the ophthalmic vein, or upon the nerves which pass to the muscles which move the eyeball More often however, the growths invade the orbital cavity through the superior orbital fissure It is not necessary that the neoplasm itself shall have extended forward into the orbit either by eroding bone or through the superior orbital fissure—the hyperostosis on the floor of the skull associated with a meningioma may produce the exophthalmos as the result of thickening or enlargement of some part of the orbital walls Whether an increase of pressure in the middle cranial fossa can produce sufficient venous stasis within the orbit so that the eyeball will markedly protrude, is doubtful As we shall mention in another part of this report, such a mechanism could not be demonstrated in any of our patients We are inclined to the view that the



Fig. 4. Roentgenogram showing hyperostosis and spicule formation in Case 2

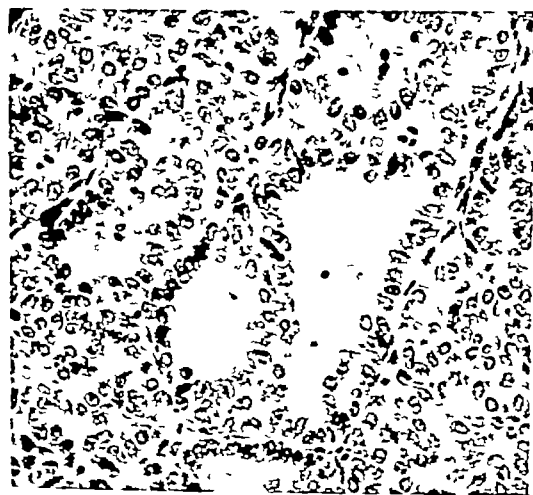


Fig. 5 Showing the characteristic structure of an adenocarcinoma in the tumor removed in Case 2



Fig. 2. Case . . . Condition before and after first operation

In the clinical records of a number of our patients with intracranial growths but the exophthalmos was never so marked that it was easily noticeable, and never caused the marked deformity that was observed in the 15 patients of this series. We have not observed marked exophthalmos in any case of frontal or temporal lobe glioma, of pituitary or bucconeural pouch tumor. In Cushing's monograph on pituitary tumors, there is no illustration or description of a case with unilateral exophthalmos.



Fig. 3A. Roentgenogram showing the destructive changes in the frontal region of the skull in Case . . .

TABLE 1.—RELATIVE FREQUENCY OF UNILATERAL EXOPHTHALMOS

Total number of tumors	807
Total number of tumors in frontal and temporal lobes	39
Total number of tumors with unilateral exophthalmos	15
Among 807 tumors, unilateral exophthalmos occurred in	0 per cent.
Among 39 tumors in the frontal or temporal lobes, unilateral exophthalmos occurred in	8 per cent.
Among 61 meningiomas in the frontal or temporal lobes, unilateral exophthalmos occurred in	16 per cent.
Among 5 tumors with unilateral exophthalmos, there were	meningiomas, or 66 per cent.
The pathological nature of the 5 tumors was the following:	
Meningiomas	3
Orbital-ethmoidal osteoma	2
Adenocarcinoma of scalp and skull, primary	1
Epidermoid	1
Paget's disease with large hyperostosis and intracranial tumor	1
	5

The frequency with which meningeal growths with large cranial hyperostoses in the anterior part of the skull, cause a protrusion of one eyeball is so great that one is apt to think only of a meningioma when a case of this kind is examined. As our 15 cases demonstrate, unilateral exophthalmos and a bony prominence on the skull occur in many different types of growth, and we have seen both conditions associated in primary carcinoma of the scalp and bone in Paget's disease invading the cranial cavity in an intracranial epidermoid



Fig. 3B. Roentgenogram showing the destructive changes in the frontal region of the skull in Case . . .

symptoms Removal of a meningioma and of the
hyperostosis Recovery

M S H 296024 Fannie G 19 years of age



Fig 6 Case 4 Unilateral exophthalmos in a patient with a large meningioma in the left frontal and temporal regions

there was no evidence that the neoplasm had perforated into or had invaded the orbital cavity

In the following case, the exophthalmos was secondary to extensive bone disease in the anterior and middle cranial fossæ on the left side

CASE 2 A history of unilateral exophthalmos and frontal swelling of 1 year's duration. At operation, an adenocarcinoma was partially removed.

N I 7577 Jennie W 50 years of age, was admitted with the history that, about 1 year before a protrusion of the left eye had been noticed and had gradually become more marked, and that a swelling in the left frontal region had appeared and had slowly increased in size. The patient did not suffer from headache and had no other complaints.

The examination failed to show any evidence of disturbances neurological in character. The patient was very co-operative, speech was normal, and mentally she was bright and alert. There was a marked exophthalmos on the left and a bony swelling in the left frontal region. The movements of the left eyeball were limited in all directions, the vision of the left eye was normal, and the fields of vision were normal.



Fig. 6. Case 2. Protrusion in the left (frontal) region and the left exophthalmos in a patient with an orbito-ethmoidal osteoma.

rise of pressure is transmitted to the orbital contents through the superior orbital fissure and that the exophthalmos results from the effect of this increase of pressure upon the contents of the orbit.

Therefore if there are the signs of a neoplasm in the anterior cranial fossa with unilateral protrusion of the eyeball but if the X ray does not show absorption of the roof of the orbit or other changes in the bone, it is probable either that the neoplasm has extended backward into the middle cranial fossa or that the growth lies mainly if not entirely behind the posterior border of the lesser wing of the sphenoid bone.

Of our 15 cases the tumor lay entirely in the anterior cranial fossa in 3 patients, and in all the roentgenogram showed that there had been some destruction of the orbital plate and extension of the growth into the orbital cavity. Two of the patients had orbito-ethmoidal osteomata, and in the third a meningeal tumor had both eroded and had caused a marked thickening of the bony roof of the orbit.



Fig. 7. Case 3. Roentgenogram showing characteristic appearance of orbito-ethmoidal osteoma.

In the 12 remaining patients the neoplasm lay mainly or entirely in the middle fossa.

CLINICAL AND DIAGNOSTIC NOTES

The protrusion of the eyeball had often been noticed for a long period before the patient came under our observation and a history of exophthalmos dating back many years (4 to 10 or more) was not unusual. In the patients in whom the exophthalmos had existed for a relatively short time—one year or less—other disturbances brought the patient to the hospital. Some of the patients were referred to us because of the increasing size of the cranial hyperostosis, others came because of diminished vision, still others on account of headache and other symptoms of an increase of intracranial pressure.

Clinically the cases could be divided into the following groups:

A. Patients whose only complaints were those referable to the changed position of the eyeball and to the deformity caused by a cranial hyperostosis or a bony swelling in the frontal region. Excepting for the proptosis and the bony changes the examination failed to show any neurological disturbances. The following short clinical histories are typical of this group:

CASE 1. A history of unilateral exophthalmos and a cranial hyperostosis of 4 years duration. No other



Fig. 8. Case 3. Roentgenogram showing the protrusion of the osteoma into the orbital cavity.

symptoms Removal of a meningioma and of the hyperostosis Recovery

M S H 296024 Fannie G 19 years of age first admitted to hospital on March 13 1925 gave a history of a swelling in the left frontotemporal region with gradual increasing bulging of the left eyeball of 4 years' duration The patient did not suffer from headache or other symptoms

Physical examination was entirely negative except for the local changes in the skull and eyeball The left frontal and temporal regions were occupied by a large bony swelling and the left eyeball protruded downward and outward The exophthalmometric readings were right eye 16, left eye 21, at 105 degrees The pupils were equal and reacted promptly to light and accommodation Vision was good in both eyes and the visual fields were complete The fundi were normal There was slight limitation of all movements of the left eyeball

The X-rays of the skull showed that there was a thickening of the anterior part of the left parietal and of the contiguous part of the left frontal bone

During the course of several years the patient was given X-ray treatment and three operations were performed Following the removal of the hyperostosis and of the intracranial meningioma there was marked diminution in the protrusion of the eyeball (Fig 1)

This was a typical case of a meningioma with a large hyperostosis which had produced no disturbances except the deformity of the skull and the protrusion of the eyeball The exophthalmos was the result of pressure upon the orbital contents of the thickened bone and



Fig 9 Case 4 Unilateral exophthalmos in a patient with a large meningioma in the left frontal and temporal regions

there was no evidence that the neoplasm had perforated into or had invaded the orbital cavity

In the following case the exophthalmos was secondary to extensive bone disease in the anterior and middle cranial fossæ on the left side

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The examination failed to show any evidence of disturbances neurological in character The patient was very co-operative, speech was normal, and mentally she was bright and alert There was a marked exophthalmos on the left and a bony swelling in the left frontal region The movements of the left eyeball were limited in all directions, the vision of the left eye was 20/20 and the fields of

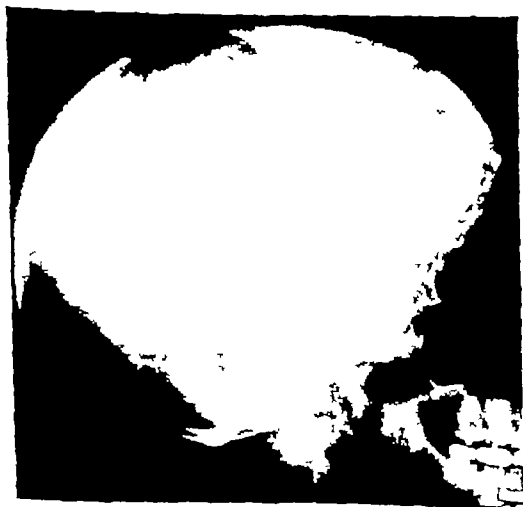


Fig 10A Case 4. Roentgenogram showing the hyperostosis



Fig 10B Case 4 Roentgenogram showing the hyperostosis

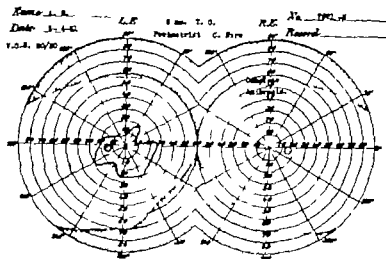


Fig. 1. Case 3. The visual fields showing the small amount of vision that remained.

both eyes were complete, the pupils of the two eyes were equal in size and both reacted well to light and accommodation. The fundi were normal.

The X-ray examination showed that there was a profound bony change in the left frontal region which involved almost the entire left frontal bone. The roentgenological appearance was that of extensive bony destruction with the spiculate formation so characteristic of the hyperostoses seen in the meningiomata (Figs. 3 and 4).

At the operation the hyperostosis which had invaded the cranial cavity was removed but no neoplasm was found inside of the dura. The pathological examination revealed that the bony change was due to an adenocarcinoma which was probably derived from a sweat gland (Fig. 5). The patient recovered satisfactorily from the operative procedure but the exophthalmos did not improve. She received intensive X-ray therapy. Further roentgen studies demonstrated an advance in the bone destruction which gradually involved the floor of the skull on the left side. Six months after the operation, the protrusion of the eye was more marked, but the patient was still free from other symptoms (Fig. 5).

Before the operative interference the diagnosis was "frontal meningioma with hyperostosis causing unilateral exophthalmos." This case demonstrated that a typical hyperostosis does not always mean that one is dealing with a meningeal growth. The extensive bone absorption might have led to the suspicion of malignant disease. Hyperostoses may occur with malignant bone tumors in other parts of the body and such cases have been reported.

The following is a characteristic story of a bony growth which had perforated into the orbit and the frontal sinus and had produced a protrusion of one eyeball.

CASE 3. Orbito-ethmoidal osteoma causing exophthalmos and a swelling in the frontal region.

N. I. 10096. Ruth R., 17 years of age, was admitted into the hospital on account of a bulging in the left frontal region of 2 years duration. The swelling had become progressively more prominent. One year ago, the protrusion of the left eye began to be noticeable and this has likewise become more marked.

The physical examination was entirely negative except for the local condition. Speech was normal. The fields were complete and vision and the fundi were normal. There was perhaps a slight limitation of the eyeball upon gaze to the left. The left eyeball was abnormally prominent and protruded downward and outward. There was a noticeable swelling in the left frontal region (Fig. 6). The X-ray report stated: "In the left frontal region there is a large irregular mass of calcification which measures 3.7 by 3.3 by 2.3 centimeters. This shadow is irregular in density. The central portion is less dense than the peripheral portion. The superior orbital plate on the left side appears denser than normal. A small portion of this mass projects into the orbital cavity and the left frontal sinus is also apparently involved" (Figs. 7 and 8).

At the operation, an orbito-ethmoidal osteoma was entirely removed.

B. In a second group, the patients had an increasing exophthalmos and perhaps a visible hyperostosis for a long period, and then began



Fig 12A. Case 5. Lateral roentgenogram showing the hyperostosis on the floor of the skull



Fig 12B. Case 5. Roentgenogram showing the hyperostosis behind the right orbit

to suffer from symptoms which led to their admission into the hospital. In many of these individuals, there were, upon examination, no neurological or other disturbances except the local condition of the eyeball. One of our patients was referred about 10 years from the time that the protrusion of the one eye had been noticed, because she had suddenly had a convulsive seizure. Another came because of failing vision 4 years after the first evidence of the unilateral exophthalmos. In a third case, attacks of headache began 9 months after the prominence of the eyeball had first been noticed.

CASE 4. A history of unilateral exophthalmos without other symptoms for 9½ years. A generalized convulsive seizure was the cause of the patient's admission into the hospital. Partial removal of a large meningioma. Death.

N I 8786 Mrs C, 36 years of age, had had a slowly increasing prominence of the left eyeball without other symptoms, for almost 10 years. On the day before admission, she had, suddenly, a generalized convulsive seizure with unconsciousness, on account of which she was sent into the hospital by her physician.

The patient was bright, co-operative, and perhaps a little euphoric. Physical examination was entirely negative, except for loss of sense of smell and the local changes.

The left eyeball protruded markedly downward and to the left (Fig 9), the globe felt tense, the discs were somewhat pale, the pupils were equal and reacted promptly to light and accommodation. In spite of the marked proptosis, the movements of the left eyeball were only slightly limited. X-ray examination. On the left side the lesser wing of the sphenoid, the posterior wall of the orbit, and the superior orbital plate were markedly thickened (Fig 10). The change involved also the left anterior clinoid process and the greater wing of the sphenoid on the same side. There was a large amount of flocculent calcification in the left temporo-frontal region.

The diagnosis of a meningioma underneath the left temporal and frontal lobes was made, and operative interference decided upon. At the craniotomy, the bone was found so thick and vascular, that the attempt to make a bone flap and to expose the neoplasm had to be done in three stages. At the third operation, considerable of the tumor was removed, but it was so extensive that its complete extirpation was impossible. One week after the last operation, the patient suddenly had a discharge of 30 cubic centimeters of pus from the nose and mouth and then began to have fever. As the operative wound was well healed, this led to the belief that the tumor had perforated into one of the air sinuses. The patient succumbed 10 days after the operation.

A large meningeal tumor, which had probably existed for 10 or more years, had pro-



Fig. 1A. Roentgenogram showing the irregular defect in the orbital plate on the left side in Case 4, an epidermoid in the middle cranial fossa.



Fig. 1B. Roentgenogram showing the irregular defect in the orbital plate on the left side in Case 4, an epidermoid in the middle cranial fossa.

duced extensive bony changes in the skull and had caused a slowly increasing exophthalmos. The protrusion of the eyeball without any

other subjective disturbances had not been considered of serious import. A convulsive seizure was the cause of the patient's admission to the hospital. If the significance of the exophthalmos had been appreciated and the patient had been operated upon many years before the result might have been a different one. The same paucity of symptoms was the explanation for the story of the next patient.

CASE 5. Unilateral exophthalmos with loss of sight in the affected eye. Diminution of vision in the other eye was the cause of the patient's admission.

N.I. 76. Anna B. 55 years of age, was admitted for study on March 4, 1931. Twenty-one years before, a bulging of the right eye had been first observed and vision in that eye had been gradually lost. The exophthalmos persisted and slowly became more marked. Three years ago, the vision in the left eye began to fall and sight in that eye had slowly become less up to the time of admission. The patient had not suffered from headache, and there had been no complaint except the visual disturbance.

Physical examination. Sight was lost on the right. There was marked protrusion of the right eyeball, and the movements of that globe were limited in all directions. The right pupil did not react to light, and the left reacted sluggishly. Vision was lost on

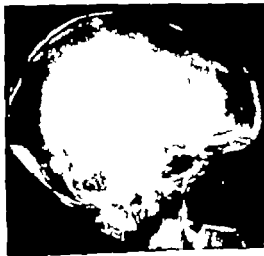


Fig. 1C. Roentgenogram showing the irregular defect in the orbital plate on the left side in Case 4, an epidermoid in the middle cranial fossa.



Fig 14. Slight exophthalmos and large hyperostosis in a patient with a large meningeoma in the left frontal region, before operation

the right, and there was only central vision on the left (Fig 11). Both optic discs were pale from primary optic atrophy. X-rays of the skull showed a thickening and increase in density of the greater and lesser wings of the sphenoid on the right side with a definite hyperostosis of the floor of the middle cranial fossa on the right. The change was characteristic of that seen in meningeal growths in the middle cranial fossa (Fig 12).

Operation was recommended in order to save vision, but on account of the absence of any other



Fig 15. Slight exophthalmos and large hyperostosis in a patient with a large meningeoma in the left frontal region, after operation

symptoms of brain tumor except the unilateral exophthalmos and failing vision the patient and her family refused to give permission for surgical interference.

In a third patient, the exophthalmos had existed for 9 months, but headache and pain in the eyeball had led the patient to seek relief.

CASE 6. Unilateral exophthalmos for 9 months followed by headache and pain in the affected eye. At the operation a large epidermoid was disclosed and removed.

NI 7025. Marjory F., 35 years of age, had noticed that the left eyeball had become progressively more prominent for 9 months. Two months



Fig 16. Unilateral exophthalmos and hyperostosis in a patient with a right frontal meningeoma

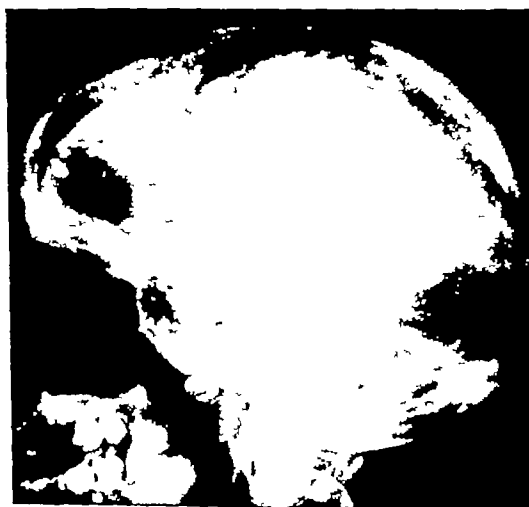


Fig 17. Roentgenogram of patient shown in Figure 16, showing the bony changes in the frontal region



Fig. 8 Unilateral exophthalmos and hyperostosis in a patient with left temporal lobe meningioma, before operation and after operation.

before admission she began to suffer from attacks of headache with pain in the left eyeball.

The patient was a robust young woman who had no complaints except those above mentioned, and the examination failed to show any neurological disturbances. The left eyeball was pushed downward and outward with the exophthalmometer right eye 15 left eye 19 at 95 degrees. There was some limitation of the movements of the left eyeball to the



Fig. 9 Anteroposterior roentgenogram showing the regular defect in the orbital wall of the patient shown in Figure 15. Note the separation of the coronal suture.



Fig. 10 Unilateral exophthalmos in a patient with advanced arterial disease and inverted tumor under the left frontal lobe.

left. Vision was 20/50 in the right eye and 20/100 in the left. The pupils were equal and reacted promptly to light and accommodation. There was a slight blurring of the margins of both optic discs.

X-ray examination showed a definite thickening of the superior orbital plate and a hyperostosis of the frontal bone on the left which extended laterally to involve the greater wing of the sphenoid on the same side. There was a definite defect 3 by 1.5 centimeters in size in the orbital plate, and the margins of the defect were smooth (Fig. 13).

As a diagnosis of middle fossa meningioma seemed justified, a bone flap was turned down. A large epidermoid containing much cholesterol and caseous material was found and removed. The protrusion of the eyeball soon disappeared, and the patient has remained well.

In spite of the hyperostosis, the clean cut and smooth walled defect in the superior orbital plate was not typical of the destructive changes in the bone observed in meningeal growths, and in a similar case, an X-ray diagnosis of middle fossa meningioma should be made with many reservations. The changes seen on the X-ray films were difficult to interpret, and one very experienced observer even suspected a congenital anomaly. The case again demonstrated that other conditions in addition to meningeal growths may produce unilateral exophthalmos and a hyperostosis.

C In a third group of patients, there was a history dating back a number of years, of slowly progressive enlargement of the bone in one frontal region with finally the occurrence of unilateral exophthalmos, followed by symptoms and signs of increased intracranial pressure. All of the patients had meningeal growths with cranial hyperostoses, and the changed bone as well as the intradural tumor made pressure upon the structures in the middle cranial fossa. One of the patients had been seen for several years before the onset of signs of increased pressure and of loss of function and she only gave consent for the surgical interference after a hemiparesis had developed (Figs. 14, 15, 27, 28). A somewhat similar story was obtained from another individual

whose photograph and X-rays are reproduced in Figures 16 and 17. In still another patient, unilateral exophthalmos developed during the course of 8 months and was caused by a large meningeal fibroblastoma which lay underneath the left temporal and frontal lobes. In this patient, the protrusion of the eyeball (Fig. 18) was the result of the pressure of the neoplasm through a greatly enlarged superior orbital fissure (Fig. 19). In one patient, who is suffering from advanced arterial disease, surgical interference has not been advised, and the diagnosis of meningioma has not been verified (Fig. 20).

THE CHANGES IN THE POSITION AND THE LIMITATION OF THE MOVEMENTS OF THE AFFECTED EYEBALL. DISTURBANCES OF VISION AND OF THE VISUAL FIELDS

In the short histories of some of the patients that have been given in this paper, little has thus far been said regarding the local conditions in the orbit and the changes in the eyeball itself. As the photographs of the patients demonstrate, the eyeball was most often pushed forward, downward, and outward. This was due, no doubt, to the fact that perforation of the orbital roof occurred more often



Fig. 21 Unilateral exophthalmos in a patient with an orbito-ethmoidal osteoma

in the medial part of the roof, and hyperostotic changes in the base were most marked in the more mesially placed lesser and greater wings of the sphenoid bone and the adjacent orbital walls. In the 2 cases of orbito-ethmoidal osteoma (Figs. 7, 8, 21, 22), the bony growth lay close to the midline of the skull in both instances and the perforation of the orbit was correspondingly near the mesial part of the roof of the orbit. In the 3 patients (Figs. 16, 23, 24) in whom the eyeball had been pushed



Fig. 22A Roentgenogram showing the orbito-ethmoidal osteoma in the patient shown in Figure 21



Fig. 22B Roentgenogram showing the orbito-ethmoidal osteoma in the patient shown in Figure 21



Fig. 3. Unilateral exophthalmos and hyperostosis in a patient with right frontal meningioma. The eyeball is pushed downward and inward.



Fig. 4. Paget's disease with intracranial tumor, hyperostosis, and unilateral exophthalmos. The eyeball is pushed downward and inward.

downward and inward, there was a large hyperostosis in the more lateral part of the frontal bone and the lateral wall of the orbit was especially involved.

The direction in which the eyeball is displaced will vary with the cause and the location of the increase of intra-orbital pressure. If the pressure is from the inner part of the orbital wall or directly through the superior orbital fissure the eyeball will be pushed outward as well as forward. If the pressure is from the side, the globe will be pushed inward as well as forward and if it is also from above or below the protrusion will be also in a downward or an upward direction. In the cases of bilateral protrusion observed in increased intracranial pressure due to chronic hydrocephalus and brain tumors, the proptosis usually is directly downward and forward, without any marked deviation to the one or other side.

In most of the patients, the movements of the affected eyeball were limited in all directions, but the limitation was not always directly proportionate to the degree of protrusion of the eyeball. In some of the patients in whom the exophthalmos was very marked there was little interference with the free movement of the affected globe or the limitation was only in upward and downward gaze.

As was to be expected the affected eyeball was always more tense than that of the other side, and when the attempt was made to push the globe back into the orbit, a much greater sense of resistance was felt than when a similar procedure was tried on the other eyeball. Pal-

pation of or pressure upon, the eyeball caused pain in the patient who had an epidermoid in the middle cranial fossa which had perforated into the orbital cavity.

Unless vision was markedly compromised, the pupils of the two eyes were equal in size and the pupil of the affected eye contracted as well to light and to accommodation as that of the other side.

The vision of the affected eye was well preserved in 6 of the patients; there was some diminution of vision in 5; marked diminution in 3 and all vision had been lost in the eye in 1 patient (Case 5). Unless a previous or co-existing papilloedema had produced more or less diminution of visual acuity the vision of the other eye was normal in all but 1 of the patients. There was nothing characteristic in the visual fields of the affected eye. In most instances, the fields were normal in shape and size. In a few there were large scotomata. In 3 patients a temporal defect was found on the affected side (Fig. 25). In the patients with papilloedema, there was, of course, more or less contraction of the fields of vision of both eyes.

The fundus changes varied within wide limits. In some of the patients, the affected eye showed a primary optic atrophy. On the side of the lesion, the margins of the disc were sometimes definitely blurred and indistinct, while the fundus of the opposite eye showed nothing abnormal. If there was a papilloedema it was found in both eyes, as an evidence of intracranial pressure. Unless there was a definite papilloedema, distinct conges-

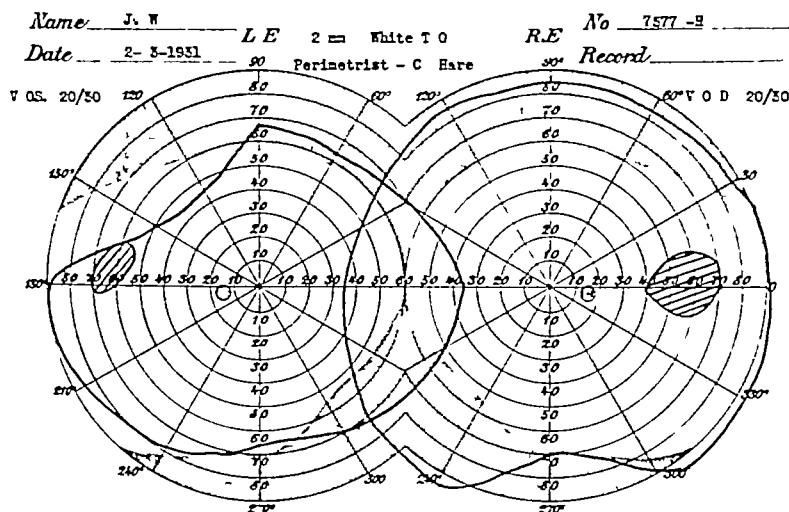


Fig 25 Visual fields of a patient with a unilateral exophthalmos on the left, showing temporal defect in the left visual field

tion of the veins of the retina of the affected eye was rarely observed. The absence of stasis in the retinal veins was surprising and led us to conclude that in our series of patients, the exophthalmos was not due to venous stasis in the orbit and the result of compression of the cavernous sinus or the ophthalmic vein.

As the protrusion of the eyeball prevented complete closure of the lids, a lagophthalmos was observed in all of the patients. Chemosis of the lower or of both lids and more or less congestion of the conjunctivæ were frequently observed.

THE ROENTGENOLOGICAL CHANGES

The roentgenograms of 10 of the patients were used as a basis for the following remarks. The films of the 5 other patients were, for one or another reason, not available. The cases included 2 of orbito-ethmoidal osteoma, 1 of adenocarcinoma of the scalp and bone, 1 of epidermoid, and 6 of meningioma.

In 7 of the cases—the 6 meningiomata and the single adenocarcinoma—there were X-ray signs of a general increase of intracranial pressure, and in 2 of them the sella turcica was markedly deformed. Atrophy of the posterior clinoid processes, the dorsum sellæ, and the floor of the sella turcica were the only evidence of increased intracranial pressure in 6

of the patients. The roentgenograms of one patient (Fig 19), who had a meningioma involving the anterior portion of the left middle cranial fossa, also showed separation of the coronal and lambdoid sutures.

In the two osteomata and in the epidermoid, there was no roentgenological evidence of pressure—which can be explained by the

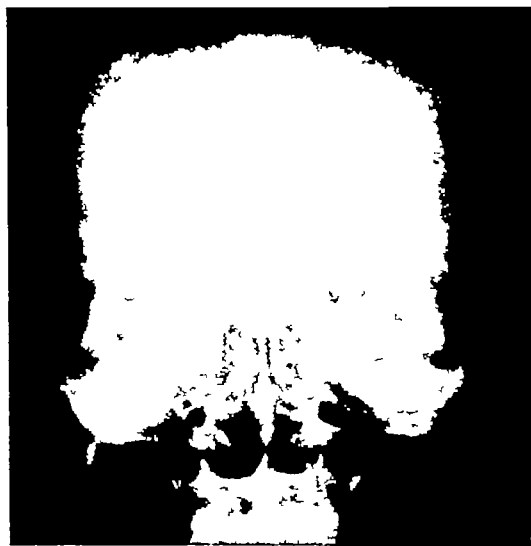


Fig 26 Roentgenogram showing destructive changes in the left sphenoid ridge in a patient with a meningioma and exophthalmos



Fig. 7. Roentgenogram showing hyperostosis in a patient with unilateral exophthalmos.



Fig. 28. Anteroposterior roentgenogram of same patient as shown in Figure 7.

slow growth of the tumors and their position. The slow increase in size of these two types of tumors appears to be the most important factor for we have not infrequently seen other tumors in practically the same situation which produced definite roentgenological signs of increased intracranial pressure.

Calcification was seen in only one of the patients of this series—a far advanced meningioma in the left middle cranial fossa (Fig. 10). The X rays in the case of the adenocarcinoma showed the marked spicule formation (Fig. 4) which is usually indicative of a meningeal growth.

In all of the 10 cases of this series the walls of the orbit were involved and there was either a definite hyperostosis or thickening or destruction or absorption of the bone. The orbital cavity was therefore directly invaded in all of the patients.

The superior orbital fissure was definitely involved in 5 cases. In 3 it was enlarged as the result of bone absorption or destruction while in the other 2 there was a definite thickening of part of its walls. In all of these 5 cases, the neoplasm was a meningioma.

When a patient with unilateral exophthalmos is examined by the roentgenologist a careful stereoscopic study of the orbital plate of the frontal bone and of the greater and lesser wings of the sphenoid should always be made. In 6 of our patients the orbital plate

of the frontal bone, and in 7 the sphenoid bone were involved.

The predominant change in the bone was productive. In 8 of the cases, there was a definite hyperostosis, and in 5 of these there was also on the X ray films evidence of bone destruction. In two of the patients with meningiomas (Figs. 19 and 26) the bony changes were entirely destructive—in one instance involving the left sphenoid ridge (Fig. 26) and in the other the greater wing of the sphenoid bone (Fig. 19). In Table II we have expressed the degree of bony change by plus signs. Four plus signifies the maximum change (Figs. 10, 17 and 28) whether productive or destructive and one plus the minimum change (Fig. 13 A B C).

The study of the films demonstrated that the superior and posterior portions of the orbital cavity were most frequently encroached upon. This was to be expected on account of the frequency with which the pathological process was located in the greater wing of the sphenoid and the orbital plate of the frontal bone.

Osteomata arising within the cranial cavity are infrequent and form less than one half of one per cent of all intracranial growths. As seen on the X ray films, they are of two types—cauliflower like growths with various degrees of density in different parts of the neoplasm and sclerosing tumors. Both increase

TABLE II.—ROENTGEN RAY FINDINGS IN TEN PATIENTS WITH UNILATERAL EXOPHTHALMOS DUE TO INTRACRANIAL TUMORS

Name	Diagnosis	Evidences of pressure	Calcification or bony tumor	Superior orbital fissure	BONES INVOLVED				Predominating bone lesion		Portion of bony orbit involved
					Ethmoid	Frontal	Sphenoid	Temporal	Productive	Destructive	
R. R. Case 3	Osteoma (Figs. 7, 8)	None	Mass 3.6 x 4.2 x 4.0 cm. 2/3 intracranial	o	o	Left orbital plate, bony mass	o	o	+++		Superior and extending laterally
W. B.	Osteoma (Fig. 22)	None	Mass 3.2 x 1.2 x 3 cm. All intra orbital	o	Arises from the junction of cribriform plate and orbital plate	Right orbital plate, smooth-edged defect	o	o	+++		Upper and inner quadrants
M. F. Case 6	Ependymoma (Fig. 13)	None	None	o	o	Left orbital plate	Orbital portion of greater wing of sphenoid	o	+	+	Posterior and upper quadrants
J. W. Case 2	Adenocarcinoma (Figs. 3, 4)	Atrophy of post. clinoids and dorsum	None	o	o	Left horizontal and upright portion	Lesser wing orbital portion of greater wing	o	+	+++	Superior and posterolateral quadrants
H. A.	Meningioma (Fig. 19)	Separation of sutures, sella atrophic	None	Enlarged laterally	o	o	Left orbital surface of greater wing of sphenoid ridge	Anterior portion of the squamous portion		+	Superior and posterior and half
A. R.	Meningioma (Fig. 26)	Sella atrophic floor deepened post. clinoids thin	None	Slightly enlarged	o	o	Left sphenoid ridge	o		+	Posterior and upper quadrants
A. B. Case 5	Meningioma (Fig. 12)	Sella very atrophic	None	Slightly decreased in size	o	o	Right greater and lesser wings of sphenoid anterior clinoid markedly thickened	Lower anterior portion of squamous portion thickened	+++		Posterior portion
E. L.	Meningioma (Fig. 17)	Atrophy of post. clinoids and dorsum	None	Increased in size	o	Right orbital plate and vertical portion, post. and lat. sup. orbital ridge and zygomatic process	Orbital surface of greater wing	Anterior part of squamous portion	++	—	Posterior and lateral
S. C. Case 4	Meningioma (Fig. 10)	Atrophic post. clinoids and dorsum Sella deepened	Moderate amount	Decreased in size	Left edge of cribriform plate	Left orbital plate, also at junction of fronto-parietal bones	Entire greater and lesser wings also left anterior clinoid	Anterior and inferior part of squamous portion	+++		Superior quadrant
G. B.	Meningioma (Figs. 27, 28)	Atrophy of post. clinoids and dorsum and deepened sella	None	o	o	Anterior portion of parietal bone. Orbital plateslightly involved	o	o	+++		Lateral

in size very slowly, and are usually found in one of two situations, either at the inner end of the petrous ridge, or at the junction of the cribriform plate of the ethmoid with the orbital plate of the frontal bone. The osteomata in the orbito-ethmoidal region concern us

here, and they must be distinguished from the hyperostoses produced by meningeal growths in this general situation. The differentiation by X ray alone may be difficult.

Epidermoids are relatively infrequent—about 90 cases have been reported in the literature. The temporal region is one of their favorite sites and they may be multiple. The defect in the bone seen on the X ray film of our one case (Fig. 13) was sharply outlined and the margins of the defect were thickened and smooth. In the meningiomata which involve the base of the skull, on the other hand bony defects are unusual, but when they do occur the margins are ragged and poorly defined. An increase in the number and size of the vascular channels in the bone is often seen in the meningeal growths.

In order to save space a detailed description of the X ray changes in all of the patients of this series is not given. A study of the accompanying table and of the roentgenograms will give the necessary information regarding the type of bone change that was found in the ten patients.

CONCLUSIONS

Marked protrusion of one eyeball may occur in tumors in the anterior cranial fossa which have perforated into the orbital cavity or in growths which are situated in the middle or in both the anterior and the middle fossae. Unilateral exophthalmos does not occur in frontal lobe growths unless they have penetrated into the orbit through the bone, or unless part of the bony walls of the orbital cavity have undergone a hyperostotic change and the thickened bone occupies space within the orbit. The main growth may however be situated in the anterior cranial fossa although much of the hyperostosis involves the bone in the middle fossa. Theoretically at least a growth may be in the frontal lobe but a localized increase of pressure in the middle fossa may be sufficient to bring about a prominence of the corresponding eyeball.

In tumors in the middle cranial fossa, on the other hand, the growth may extend into the orbit through the superior orbital fissure or the neoplasm or a hyperostosis associated with it, may produce an increase of pressure

in the middle fossa which is transmitted to the orbital cavity. The superior orbital fissure may be enlarged as the result of bone destruction and its margins may be much thickened. The superior and posterior portions of the orbital cavity are most frequently encroached upon. Venous stasis may also occur but it is rarely if ever the actual or main cause of the protrusion of the eyeball. Unilateral exophthalmos is frequent in the frontal or temporal lobe meningiomata with large cranial hyperostoses, but it may be produced by other varieties of intracranial neoplasm.

For a period of years an exophthalmos and a small hyperostosis may be the only signs of a serious intracranial lesion and there is often a long delay before the condition is recognized and the patient referred to the surgeon. The patient himself may procrastinate or be unwilling to submit to a cranial operation because of the absence or the paucity of symptoms. A combination of circumstances may therefore bring it about that surgical aid is invoked when the exophthalmos has already become very marked or the cranial hyperostosis very deforming—at a period when the intracranial neoplasm is of large size.

The results of surgical therapy would have been better if many of our patients had been operated upon earlier and in most of them the technical difficulties encountered during the surgical procedures would have been less if the neoplastic disease had not been so far advanced.

In the absence of demonstrable disease in the orbit or the neighboring air sinuses, a slowly increasing unilateral exophthalmos may be therefore, an important sign of an intracranial lesion expanding in nature. It is not at all necessary that the patient shall have other symptoms or signs of a brain tumor. The protrusion of the one eyeball may occur without any other evidence of disease, or the X rays may demonstrate a hyperostosis in the anterior or middle cranial fossa or evidence of destruction of part of the walls of the orbit.

SUMMARY

1. In a series of 807 intracranial tumors, marked unilateral exophthalmos was observed in 15 patients.

2 Most of the tumors were meningeal fibroblastomata, but exophthalmos occurred also in a case of primary carcinoma of a sweat gland of the scalp, in an epidermoid in the middle cranial fossa, in 2 cases of orbito-ethmoidal osteoma, and in a case of Paget's disease with intracranial complications

3 Unilateral exophthalmos may also occur in metastatic carcinoma and venous and arteriovenous angiomas

4 The protrusion of one eyeball was often, for a number of years, the only symptom

5 The exophthalmos was most frequently on the left side in females and on the right side in males

6 In many of the patients there was also a cranial hyperostosis—visible when on the vertex and demonstrable by X-rays when on the base

7 The protrusion of the eyeball was most often due to perforation of the tumor into the orbit, thickening of the orbital walls, extension of the growth through an enlarged superior orbital fissure, or increase of pressure in the middle cranial fossa directly transmitted to the orbital contents through the superior orbital fissure

8 There was no positive evidence in any of the patients that the unilateral exophthalmos was the result of compression of the cav-

ernous sinus or the ophthalmic veins and venous stasis

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HICCUP¹

CHARLES W. MAYO, A.B., M.D. ROCHESTER, MINNESOTA
 Division of Surgery The Mayo Clinic

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HISTORICAL ASPECTS

Historically the subject of hiccup is old. References to it go back hundreds of years, both in non-medical and in medical literature. Treatments were multiple and varied. Pliny suggested fifteen or sixteen "cures." During the medieval period Paulus Aegineta discussed the subject from the standpoints of etiology and treatment. "Fullness of the stomach, the presence of acid or pungent humours in the stomach" and "rigors" (chills) were the causes he recognized and his treatment he based on reason. When the stomach was distended, or "spoiled food" was found in it, the stomach was emptied by emetics and strong evacuation was brought about. Evacuation was assisted by sneezing. When the stomach is empty sneezing will not cure it." When hiccup was present and the stomach empty Aegineta suggested rue with wine or nitre in honeyed water or hartwort, or carrot or

cumin or ginger, or calamint or celtic nard."

Retaining the breath is likewise of great use," he asserted.

Galen dismissed hiccup, saying that it was occasioned by an exciting cause which aroused the stomach to violent emotions, and sneezing proved a cure to it. Celsus felt that frequent and unusual hiccup was symptomatic of an inflamed liver. Aetius stated that singultus in fevers often arises from inflammation of the stomach and neighboring parts. When it was caused by "pungent humors" he gave an emetic, then narcotics such as opium, and in severe cases applied cupping instruments, with great heat, to the breast, stomach, and back. The Arabians and the Methodist school of medicine also agreed that the cause of hiccup was inflammation of the stomach.

In a book entitled *A Thousand Notable Things of Sundrie Sortes* by Thomas Lupton, published in London in 1657 is found the following, referring to hiccup: "stop both your ears with your fingers and the hiccup (hiccup) will go away within a while after. Proved." And later "It is proved and a secret that if you give to them that have a hiccup (hiccup) every morning three hours before meale one roote of green ginger and immediately after drinking two draughts of Malmesey you shall see that he will become cured."

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There are few people who have not at some time or other had hiccup of some type and a description of the condition is consequently unnecessary. Its treatment, however in many instances, is today as much a problem as ever and it seems justifiable to attempt to discuss and suggest lines of thought and lines of treatment in connection with the subject.

¹Read before the Kentucky Hospital Council, Louisville, Pennsylvania, April 22, before the George Washington Medical Society, Washington, D. C., April 24, and before the Kentucky County Medical Society, Nashville, Virginia, April 26, 1917.

CLASSIFICATION

To be of value a classification must have two requisites, it must be applicable and must be simple. A classification of disease is best made on an etiological basis for if treatment is to be other than "hit or miss" it must be directed intelligently toward the cause or causes.

It will be noted in the classification which follows, the first group is headed "Infectious persistent hiccup." I am well aware of the fact that in using the adjective "infectious" I bring up a matter which may be debatable, inasmuch as there are those who do not believe that afflictions such as epidemic hiccup should be so classified. I do not feel qualified to argue the question from a bacteriological standpoint, but from a clinical standpoint the term seems justifiable. Although our bacteriological studies on postoperative persistent hiccup are not yet complete, the evidence at the present time would indicate that in this group the word "infectious" is also correctly used.

- Infectious persistent hiccup (usually central)
 - Epidemic
 - Postoperative
- Chemical hiccup
 - Central (this is of questionable existence)
 - Peripheral (reflex from chemical irritation of the stomach, intestine, diaphragm or of some structure of the same somatic segment as the diaphragm)
- Mechanical hiccup (reflex from pressure)
 - Central
 - Tumor
 - Vascular disturbance
 - Peripheral
 - Stomach
 - Rapid dilation
 - Slow dilation of long duration
 - Tumor (irritation of diaphragm or of reflex arc that involves phrenic nerves)
 - Neoplastic
 - Inflammatory
 - Vascular disturbance
 - Hysterical or psychic hiccup
 - Indeterminate hiccup

TREATMENT IN GENERAL

It is difficult in many cases to determine the cause of hiccup. Particularly is this true after operation, when the picture is masked by the effects of the surgery. Thus, it may

be necessary to assume a definite cause and to treat accordingly. For example, if a man 40 years of age or more develops hiccup within 3 weeks after operation, the ordinary methods of treatment should be tried. One of these is lavage. Another, which also aids in ruling out gastric dilation and chemical irritation of the gastric mucosa is the administration of soda water. If these methods of treatment, and if narcotics and sedatives give but temporary relief, then it is fair to assume that the cause is central infection and to give encephalitic antistreptococcus serum, sedatives and other means being used to give temporary relief until the effect of the serum has an opportunity to manifest itself. If, again, the assumption of the cause has been correct, then the effect should be noted in most cases within a few hours.

TREATMENT OF INFECTIOUS PERSISTENT HICCUP

It is my impression that a vast majority of cases of the persistent type of hiccup are caused by a specific organism. This belief is supported by numerous cases studied and reported by Rosenow with particular reference to epidemic hiccup, also, by the studies of Rosendaal and me in relation to postoperative hiccup. Occasionally persistent hiccup may come from other causes than specific infection (if so it may be possible to classify it as of the hysterical or mechanical type).

Epidemic form. The evidence points toward the conclusion that epidemic hiccup is caused by a specific organism. The disease is exhausting because of its tenacity, respecting neither night nor day, patient nor physician, usual medication nor prayers. It may last for a few days, weeks, or even months, but fortunately contagion is not usually demonstrable.

The work of Rosenow is outstanding in this connection, and I can best consider the condition by briefly summarizing his work. Epidemic hiccup is closely related to epidemic encephalitis. The two diseases frequently occur together in the same locality at the same time and occasionally affect the same patient. Bacteriologically, there is also a close relationship. Rosenow, by repeated passage of the organism through animals, has demonstrated

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¹Read before the Ramsey Memorial General Staff, Rochester, February, April 22, before the George Washington Medical Society, Washington, D. C., April 16 and before the Norfolk County Medical Society, Norfolk, Virginia, April 18, 1921.

cases which came under our observation, and we were able to recover from throat swabs a neurogenic type of streptococcus, which, inoculated into animals, produced spasms of the diaphragm. A further report of these experiments is being prepared.

That there is a relationship between the organisms of epidemic encephalitis and of epidemic hiccup is fortunate, because the encephalitis antibody globulin solution as prepared by Rosenow can be applied in treatment. Such treatment was given in those of our cases in which persistent hiccup was present, and we were able to recover the neurogenic streptococcus from the throat and reproduce spasms in animals. The effect of the serum was dramatic in many instances, all symptoms of hiccup disappearing within a few hours.

There are, then, three lines of treatment to follow in cases of epidemic and postoperative infectious persistent hiccup: (1) specific treatment, which is aimed at the cause, (2) symptomatic treatment, and (3) general treatment.

For specific treatment encephalitic antibody globulin solution is administered. First the patient is tested for hypersensitiveness to horse serum, by injecting not more than 0.05 cubic centimeter of the serum subcutaneously. If no urticarial wheal, associated with itching, develops in 20 minutes the therapeutic injection may be given. If the patient is sensitive, desensitization should be carried out by giving from 4 to 6 subcutaneous injections at intervals of half to one hour in doses increasing from 0.1 to 1.0 cubic centimeter. If no reaction occurs following these injections, the first therapeutic dose may be given. In acute cases of epidemic or persistent postoperative infectious hiccup, 2 to 5 cubic centimeters of the serum should be given twice or thrice daily for 2 or 3 days, depending on the age of the patient, on the acuteness of the symptoms, and on the results obtained. These injections are to be given intramuscularly and should be followed by massage to facilitate absorption.

I have found that in most instances the hiccup in these cases is controlled in an hour to 4 hours after the first dose, and consequently have not found it necessary in many cases to give more than two doses. As with

other solutions in which horse serum is the base, occasionally on or about the seventh day after injection an itching dermatitis may develop. None of these sequelæ has been serious, and the patient can be kept comfortable with calamine lotion and other substances containing phenol.

Symptomatic treatment is a reasonable procedure to follow during the entire course of hiccup. Its object is to lower tonicity of nerves and muscles. If the case is of a truly infectious type, nothing more can be expected from this treatment. It applies mainly to the diaphragm, phrenic nerves, and brain. The substances used are as follows: morphine sulphate, with or without atropine, codeine, with or without atropine, camphorated tincture of opium, barbiturates given by mouth or intravenously (sodium *iso*amylethyl barbiturate known as sodium amytal, or pentobarbital sodium), bromides, phenobarbital (luminal), barbital (veronal), the mixture of allylisopropyl barbituric acid and aminopyrine (alional), chloral, chlorbutanol (chloretone), quinine (3), carbon dioxide and oxygen by inhalation, anaesthesia by inhalation, rest and quiet.

Carbon dioxide alone is dangerous, consequently, tanks containing the proper mixture are advantageous. Such tanks contain carbon dioxide combined with oxygen 5 to 10 per cent. A simple and more fool-proof method is rebreathing from a mask and rubber bag, even a paper sack may be used. These methods should not be applied for more than 15 minutes at a time.

Self anaesthesia is occasionally advantageous and if used should be carried out with the patient in a sitting position and with no arm rest. Ether or chloroform is poured on a piece of gauze and held to the nose by the patient. When a sufficient amount has been inhaled, the patient removes it himself, or relaxing the unsupported arm cuts off further dosage.

It may be that more than one factor enters into the cause of hiccup. Therefore it is essential to consider the case from other angles than that of infection, even though the case may fulfill the requirements for the conclusion that it is of infectious origin.

General treatment consists of measures which tend to build up bodily resistance. It

a change in the character of symptoms produced, from that of hiccup to those of lethargic encephalitis. He felt that a change in tropism or localizing power on the part of the organism during repeated animal passage explained this phenomenon.

The causative organism isolated from patients suffering from epidemic hiccup is a neurogenic type of streptococcus in short chains (*Streptococcus singultus*). It may be obtained from the throat and also from the urine and blood. The organism, likewise, has been isolated from the brain and spinal fluid of inoculated animals in which hiccup developed. It is gram positive, not encapsulated, produces greenish colonies on blood agar plates, and grows in short chains in liquid medium. In glucose-brain broth the growth is rapid and diffuse, and aerobic cultivation destroys its specificity.

In animals, the pathological findings do not appear to concern the phrenic nerves directly rather are they confined to the basal ganglia, to the walls of the ventricles, and to the gray matter of the cortex and medulla, in varying extent. Microscopically may be seen circumscribed areas of hemorrhagic necrosis, and infiltration with leucocytes and round cells especially about blood vessels. In acute lesions bacteria may be found.

The symptoms and lesions produced in animals by injections of active filtrates, and of suspensions of dead bacteria and of living bacteria are essentially alike according to Rose now. Symptoms of shortest duration follow injection of filtrates, those of longest duration follow injection of living bacteria. "The localizing power of this streptococcus consequently would seem to be due to a chemical substance produced either by the streptococcus or during the reaction incited in the host." The treatment of epidemic hiccup is considered together with that of persistent postoperative hiccup.

Postoperative form. It seemed to me that perhaps many of the cases of persistent postoperative hiccup might be due to a specific organism as in epidemic hiccup. Following this hypothesis, and reviewing cases, many interesting facts came to light, some of which might be worthy of note.

The condition has affected, as far as I have observed, men only for the most part, men of more than 45 years of age, the average being 54.5 years. It may follow major operations on the colon, the urinary tract (especially the prostate gland and the bladder) the gall bladder, the stomach, and occasionally other structures. If the cases which followed gastric surgery be omitted the shortest duration of the hiccup was 4 days, the longest 27 days, the average, 9.7 days.

This type of hiccup, which is persistent and which comes on after operation seems to run a definite course, varying only in intensity and duration, the course is such as might be run by any infectious disease. In the early and late part of its progress it is amenable to symptomatic treatment, from which temporary relief may be expected. At its height, however, no measures for relief that are directed against symptoms have any appreciable value, except radical steps such as bilateral phrenicosis or phrenicotomy. These measures are extreme and should not be adopted except as last resorts.

The onset of this unfortunate complication may be on any day after operation, but usually some time between the first and the seventh days. The condition is not seen in any one season, however, there is a greater incidence between and including the months of November and April.

On the basis that I have known a 16 day attack of hiccup to follow prostatic massage, that I have seen only males affected, and that a large majority were more than 45 years of age, that in those surgical cases in which the condition did occur as a complication, usually there were also urinary symptoms present or there had been disturbance of the prostate gland such as required repeated catheterization or an indwelling catheter I have the hypothesis that the primary focus of the infection is the prostate gland. Not that all prostate glands harbor the specific organism, but certain men are potential victims of the infection, given the proper condition.

On the assumption, then, that persistent postoperative hiccup might be caused by a specific organism, Rosendahl and I made a clinical and bacteriological study of several

most part the inciting condition is subdiaphragmatic abscess, supradiaphragmatic abscess, or other inflammatory condition situated contiguous to the diaphragm, the source of irritation may be distant, but segmental. Here medical or surgical skill is called for, as the individual case may indicate.

Elkin has reported a case of direct reflex hiccup. The patient was a negro aged 28 years, who 8 days prior to the time that Elkin saw him had received a stab wound in the left trapezius muscle. The fourth day after the injury he began to hiccup. The tissue about the stab wound was fluctuant, and on being opened was found to contain about 15 cubic centimeters of pus. Fluoroscopic examination of the thorax gave evidence of paroxysmal contractions of the diaphragm, occurring about ten times each minute. Phenobarbital (luminal), bromides, chloral, sodium isoamyl-ethyl barbiturate (sodium amytal) and morphine were given for 3 days without effect. On the seventh day of hiccup, the left phrenic nerve was crushed, and hiccup ceased within 30 minutes, returned for 20 minutes the following day, and from then on recovery was uneventful.

TREATMENT OF MECHANICAL HICCUP

The structures concerned with the reflex arc may be excited by mechanical means, such as pressure.

Central form. Among central causes are tumors of the brain, which may result in direct pressure because of their position, or they may result in secondary pressure. If the pressure is direct, operation may be directed at the tumor itself, or decompression may be directed at relieving the pressure, or symptomatic treatment may be directed at the hiccup itself, the cause being disregarded. If secondary pressure from tumor of the brain is considered to be an etiological factor in hiccup of central origin, the following treatments, which involve the use of hypertonic solutions, should be considered: glucose, in 10 or 20 per cent solution, given intravenously, magnesium sulphate in retention enemas, hypertonic cathartics of which the action is based on the principle of drawing fluid into the intestinal tract, and spinal puncture. Symptomatic treatment can also be carried out as described.

Another class of central causes is vascular disturbances, either within the brain, or concerned with the blood supply of the brain particularly the brain stem. These vascular abnormalities may directly interfere with the hiccup center, which presumably is in the brain stem near the respiratory center. They may interfere, secondarily, with that center as a result of increased intracranial pressure.

Treatment is rarely surgical, and is usually confined to symptomatic measures and to relief of pressure by use of hypertonic solutions, as suggested. It is well to remember also that it is possible to have, as the primary cause of hiccup and vascular disturbance, the presence of the *Streptococcus singultus* as has been demonstrated by Rosenow (16) in a report of a case of thrombosis of the cerebellar and vertebral arteries associated with intermittent hiccup. Rosenow was able to recover the streptococcus from the throat and urine during life, and from the blood stream after death, and to reproduce the spasm and evidence of central localization in animals.

Peripheral form. The first subgroup under this type has to do with disturbance of the stomach. Rapid gastric dilation as a cause of hiccup is illustrated by the hiccup which afflicts infants. Their small, young stomachs are rapidly filled to more than normal capacity, and hiccup is a not infrequent occurrence. The mother or nurse has to balance the child just so over the shoulder to "get up the bubble," a procedure usually accompanied by partial return of ingested milk. Physiologically, the spasms may aid in the forcing of stomach content through the pylorus and into the small intestine by the downward force of the diaphragm and the spontaneous tightening of the abdominal muscles.

Rapid dilation, also, accounts for hiccup which follows heavy meals taken by adults. In fact, most of the so-called simple hiccup of short duration is caused by rapid dilation, and methods most efficacious in treatment are those which empty the stomach, either removing the content from above or aiding in forcing the content into the small intestine. Thus, hiccup of this sort will eventually cure itself, but it is uncomfortable, and means are at hand to hurry the procedure. It is best to begin

may be necessary to combat dehydration, to control diabetes, to support a deficient heart, to increase output of fluid to improve elimination in other ways, to build up a carbohydrate reserve, and to treat anemia. Many possibilities are to be considered, and each case is a problem unto itself.

TREATMENT OF CHEMICAL HICCUP

As a group this type is somewhat difficult to define. It contains particularly those cases of hiccup caused by ingestion of highly irritating foods or liquids and it is generally of comparatively brief duration. The chemical factor may be combined with a mechanical one. Particularly is this true when hiccup follows gastric operations. For a few days, swelling and edema may interfere with gastric motility and the outlet or outlets, new or old, may function badly. Gastric secretion and old blood may be retained and become rancid, creating chemical irritation and causing or being a contributory cause to reflex hiccup.

It is in the group of chemical hiccup that alcoholic hiccup falls, and those cases referred to by Paulus Aegineta when he stated many people hiccup when the food spoils on the stomach."

Treatment must consist in removal of the cause, which is best accomplished by emptying the stomach, keeping it empty if the content cannot pass through, or if the outlet of the stomach is patent, aiding in rapid passage through the intestinal tract what has not been vomited or washed out with a stomach tube. To accomplish this, large doses of a bland oil are better than an irritating cathartic. Copious enemas also induce greater peristalsis and aid in elimination.

The following measures might be classed as specific treatment: gastric lavage, single, repeated or constant, such as can be effected through an indwelling nasal Rehfuss tube; administration of emetics, such as apomorphine; giving of large doses of hot water, soda water, mustard and so forth; administration of laxatives rather than cathartics; administration of enemas which may contain turpentine and administration of pituitrin. Of the last substance a surgical ampul is given in divided doses, either with an enema or alone.

Symptomatic treatment may be necessary. It should not interfere with treatment aimed at the cause. After the causative agent has been eliminated treatment should be directed at the hiccup itself. It being remembered that if the hiccup continues after repeated lavage, the cause of the irritation still remains and must be properly treated. One is likely to forget this, and to begin dribbling into the stomach in repeated doses such additional irritants as Hoffman's anodyne, and chloroform and sugar. These temporarily anesthetize the nerve receptors, but they tend to aggravate the condition or to prolong the course of the hiccup when the numbing effect has worn off. After specific treatment has been carried out, and in cases in which a mechanical factor is not present, one or more of the following substances or methods may be used.

Repeated small doses of sodium bicarbonate, or a similar mildly alkaline substance in water, olive oil in small doses (or mineral oil), barbitol (veronal) in warm milk, ice cream, sips of warm water, soft diet, no harsh foods for a few days, as few drugs as possible, and sprays to the throat of a 2 per cent solution of cocaine followed by application of 20 per cent cocaine to the larynx by indirect laryngoscopy. Any solution of cocaine so applied must be freshly prepared to be entirely safe. Again, by indirect laryngoscopy about 1 cubic centimeter of 4 per cent cocaine in a laryngeal syringe is instilled, drop by drop, between the vocal cords into the trachea. By the same method warm plain alcohol is then dropped into the larynx and trachea. Treatment by spray and direct application such as this, repeated once a day for a few days, has been reported to give temporary relief. The rationale is that cocaine abolishes the afferent source of reflex irritation via the vagus nerves, the efferent path being of course, through the phrenic nerves (4).

It is within the realm of reason to suppose that the chemical change produced in cells by inflammatory reaction near the diaphragm or for that matter in any part of the reflex arc concerned with hiccup, may be the inciting cause of the phenomena. Clinically such a cause may be difficult to determine for the

ment, of course, should be such as will have a psychological effect. The condition is caused by suggestion which may be subconscious, and it may be cured by persuasion. The type of persuasion depends on the individual case, and varies from mild to almost inhumane methods. The mental basis for the hiccup should be determined if possible. Then the following may be tried: reasoning, which is rarely successful, contrast baths, continued administration of sedatives in large doses but no opiates unless necessary, emetics, particularly apomorphine by hypodermic injection, repeated lavage, large tubes being used, anaesthesia, indirect tracheal intubation, the tube being left in place several hours, and phrenicclasis.

A typical case of hysterical hiccup of a girl of 23 years was reported by New. Hiccup that had lasted intermittently for months was cured permanently by two intubations with an O'Dwyer tube of large size. The tube was left in place the last time for 8 hours.

TREATMENT OF INDETERMINATE HICCUP

In this group are included those cases which cannot be justifiably placed in any of the other groups. It is the hope that it will prove to be a small group and will grow smaller as cases of hiccup are more closely analyzed. Treatment here is necessarily of a blind type. Should the hiccup be persistent, the known specific treatments for cases in the other groups should be tried. For example, encephalitic antistreptococcus serum, or encephalitic antibody globulin solution should be given. If all such measures fail, operation on the phrenic nerves must be considered.

SURGERY DIRECTED AT CUTTING THE REFLEX ARC

Surgical procedures on the phrenic nerves to control hiccup, attack the symptom but not the cause. Consequently such a method should not be resorted to until all others have failed. Undoubtedly there is a place for phrenic neurectomy, avulsion of the phrenic nerves, and phrenicclasis. It may be noted in the literature that such surgical measures have been taken after several days of hiccup.

The following considerations should be thought of before operation is attempted.

most cases of persistent hiccup, epidemic or postoperative, among men, are on basis of infection with a specific organism. If specific treatment has not been applied it should be remembered that like most other infectious conditions, infectious hiccup runs a definite course, varying only in severity and duration. On an average, $9\frac{1}{2}$ days is the duration of hiccup as a postoperative complication. The longest duration of which I know was 27 days. Operation means additional trauma to already well exhausted patients. However, operation on the phrenic nerves to control hiccup may be advisedly done in some cases. It must be based on evaluation of previous treatment, on one's being convinced that the condition has not about run its course and is ready to stop spontaneously, and on thorough consideration of the individual patient from the angles of physical and mental depression and exhaustion. If other methods have failed, and the hiccup has lasted for weeks, phrenicclasis, as described by Egan is the surgical procedure of choice. If, on the other hand, hiccup has lasted months, phrenicectomy or phrenic avulsion is perhaps the best method of control. Crushing or cutting the left phrenic nerve may only decrease the severity of the condition, but will not eliminate hiccup unless it is ready to stop spontaneously. Thus, this measure may falsely be considered curative.

THE POSSIBILITY OF AUTOVACCINATION

The following cases I am reporting in more detail to illustrate the possibility of auto-vaccination in hiccup.

CASE 1. A man, aged 60 years, underwent extra-vesical excision of bladder diverticula, June 25, 1929. The second day after operation hiccup began. At first it was easily but temporarily controlled by ordinary methods. As time wore on the complication became more severe (graded 4), and was no longer controlled at all well. Sodium isoamylethyl barbiturate (sodium amyltal) in doses of 5 grains required 1 hour to take effect, and gave relief for 2 hours at most. Morphine and codeine were the other drugs which in comparatively large doses could be counted on to give temporary relief. Carbon dioxide gave relief at the height of the hiccup, but only for 20 minutes. The postoperative convalescence as a whole was stormy, the temperature ranging from 100 to 102.5 degrees F for a number of days, and the average pulse rate was 95 beats each minute. The duration of the hiccup was 8 days.

with simple measures in most instances. These are having the patient inspire and hold the breath or blow into a bottle, or drink water while holding the breath giving bicarbonate of soda or similar substances in solution exerting traction on the tongue for a minutes inducing sneezing by tickling the nose with a feather lowering the head and dilating the anus causing the patient to sip hot or cold water or hold ice in the mouth giving sudden shock by taking the patient unawares with a loud noise telling the patient to stand on the hands or the head or to drink lemon juice and salt, or to take a teaspoonful of vinegar and sugar flexing the legs of the patient on the thighs and the thighs on the abdomen putting a compress of ice on the epigastrium with the patient's arms vertical, directing him to open the mouth wide and to extend the tongue causing the patient to concentrate on the effort to put the points of two pins together compressing the eyeballs (5) exerting pressure over the fifth cervical vertebra giving atropine or belladonna to relax the pyloric sphincter inducing vomiting by tickling the throat employing gastric lavage and administration of emetics such as apomorphine.

It is possible that hiccup from rapid gastric dilation may be an additional symptom in a complex condition for which surgery is required in such a case, of course, surgery dispels the symptom.

Slow gastric dilation as a cause of hiccup is more difficult to treat. Chronic obstruction, constipation and asthenia with lack of tonus in the intestinal tract are the principle causes. Surgery may also be indicated in this type of case to relieve obstruction. Medically patients should be treated to bring back intestinal tonus, and to correct constipation by proper diet and well directed medication frequently anemia is part of the picture, and tonics can be given with benefit.

A large, toneless stomach can sometimes be reduced in size by keeping it empty for a number of days giving repeated lavage, and in the meantime supplying fluids by proctolysis, or by subcutaneous or intravenous injection.

The second subgroup of mechanical peripheral causes of hiccup is concerned with dis-

turbances caused by tumors. Neoplastic or inflammatory growths, may by direct contact with peripheral structures concerned with the reflex system of hiccup cause the phenomena under consideration. Roentgen rays are the chief means of determining the presence of tumor when clinical evidence fails. In one case which came under my observation and in which cholecystectomy and appendectomy had been done hiccup for 9 days ensued. Roentgenograms of the thorax revealed a large mediastinal tumor and although a therapeutic test was not made in this case, it was assumed that the cause of the hiccup was mechanical, because of the proximity of the mass to the phrenic nerves.

Treatment is surgical when possible and is directed at the growth. Either roentgen rays, radium, or both, is the next choice. In the meantime, symptomatic treatment must be instituted as previously has been said. If the hiccup continues, the decision may have to be to operate directly on the phrenic nerves. If a neoplastic growth is the cause, phrenic neurectomy with avulsion of the nerve, is the procedure of choice.

The third subgroup of mechanical peripheral causes of hiccup has to do with vascular disturbances. Aortic aneurism occasionally may produce hiccup. If persistent, operation on the phrenic nerves may be indicated otherwise treatment in these cases should be symptomatic.

TREATMENT OF HYSTERICAL OR PSYCHIC HICUP

It has been wisely said that within the realm of hysteria all conditions may be simulated. Thus, we may be led far astray in the search for a cause of hiccup when such an etiological factor lies at the base of it. We do have, however certain points which may give leads. The condition is most common among young women between 18 and 35 years of age. It is rare among men. No cases have been reported. The affected patients have a predisposition to hysterical manifestations, and are likely to be of inferior nervous makeup.

This type of hiccup may be of brief duration, but more commonly it is persistent and it may last days, weeks, or months. Treat-

THE ACUTE GALL BLADDER MANIFESTING FEW SIGNS OR SYMPTOMS

STANLEY H. MENTZER, M D, M S, F A C S, SAN FRANCISCO, CALIFORNIA

* From the Department of Surgery, University of California Medical School

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A universal classification of cholecystic disease would simplify the problem. Certain types of acute cholecystitis are treated similarly the world over. Thus, acute catarrhal cholecystitis is never considered a surgical problem, while acute gangrenous cholecystitis necessitates immediate operative care. Our problem lies not in these but in other acute gall-bladder lesions, namely, acute exacerbations of chronic cholecystitis, acute hydrops, acute empyema, necrotic oedema (7), acute phlegmonous cholecystitis, and acute or sub-acute perforation of the gall bladder. The problem would be still further simplified if we could anticipate the type of acute lesion present, but herein lies much of our difficulty, as this differentiation is often quite impossible. Occasionally the careful diagnostician correctly delineates the pathology present, but often it is impossible to judge the stage of the disease properly. Therefore, it has been considered best to delay surgical intervention until the diagnosis is adequately established and until the acute inflammatory lesion has somewhat subsided. The results of this procedure can be evaluated from the following data.

During the 12 year period between 1919 and 1931, there were 91,495 patients admitted to the San Francisco Hospital, not including those having tonsillectomies. Of these, 23,864 were operated upon, approximately one-fourth. These included 1,614 patients suffering from cholecystic disease, less than one-fourth of these were operated upon. A diagnosis of "acute cholecystitis" was made in 249. After reviewing the histories, I eliminated 115 as not sufficiently acute to be studied in this paper. Therefore, only 134 of the 1,614 gall-bladder entrances were for

"acute cholecystitis" (8.2 per cent), approximately 0.56 per cent of the total hospital operative cases or 0.046 per cent of the total hospital admissions, not including the tonsillectomies. In comparison with other acute abdominal lesions, acute cholecystitis was about one-tenth as frequent as acute appendicitis, one-half as frequent as perforated gastric or duodenal ulcers, and twice as frequent as acute intestinal obstruction.

The total cholecystic lesions encountered during the period between 1919 and 1931 were grouped as follows: 93 cases of pericholecystitis, 134 of acute cholecystitis, 630 of chronic cholecystitis, 639 cases of chronic cholelithiasis, and 118 of common duct stone or carcinoma.

The cases of acute cholecystitis are tabulated in Table I. It will be noted that 4 instances of perforation occurred in patients while under medical observation. In none of these was the perforation recognized by the clinicians before death. Furthermore, 4 instances of acute empyema treated medically died of peritonitis. In 1 of these patients peritonitis was recognized and believed to emanate from an acute cholecystitis, but the acute peritoneal reaction was not diagnosed. In the second patient, an acute empyema of the gall bladder had been suspected. In both instances the clinicians awaited localization of the acute inflammatory lesion before calling surgical consultation. In 1 case, the acute cholecystic disease was not suspected, the other patient refused to be operated upon. These errors, of course, cannot be construed as indictments against the physician. They serve as illustrations along with other cases more fully discussed later in this paper, of pathology the severity of which cannot always be evaluated before operation.

A comparison of the medical and surgical mortality further emphasizes the difficulty of recognizing how severe an acute cholecystitis

Three months later to the day suprapubic prostatectomy was performed. The postoperative course was uneventful and no indication of hiccup was present at any time.

CASE 2: A man, aged 45 years, had undergone gastro-enterostomy elsewhere in 1909, following which he had retention hiccup for a day that was relieved by lavage. In 1913 oestero-anastomosis was performed at the clinic and uneventful convalescence ensued, with no hiccup. In May of 1931 cholecystectomy and closure of a cholecystogastric fistula was done. The evening of the day of operation hiccup began, which was temporarily controlled by inhalations of carbon dioxide and drinking of soda water. He obtained best relief by merely keeping quiet. The hiccup lasted more than 6 days severity was graded 3 on a basis of 4. One month afterward, repair of a unilateral inguinal hernia was done, and 5 or 6 days later mild hiccup developed, which could be graded at less than 1 in severity and which lasted only 5 days.

It will be noted that in the cases reported the first patient had severe hiccup, the second a much milder case. The first patient did not have recurrence following the next operation 3 months later. The second patient had very mild recurrence of hiccup after his operation for hernia, which was done a month after the operation which had involved the upper part of the abdomen.

In the files of the clinic also are records of cases in which hiccup developed although no sign of the complication was present following operation on the same patient 2 to 3 months previously. It would seem, then, that the organism lies dormant until such time as either its virulence is increased or the resistance of the patient is so low that an organism that ordinarily is under control becomes virulent. On the other hand, as Rosemow believes, there may be cycles in the life history of these organisms as they exist in nature, and at cer-

tain times of the year they are more virulent than at others and patients are thus infected from outside sources.

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TABLE I.—TOTAL MORTALITY STATISTICS

Pathology	Medical mortality			Surgical mortality		
	Cases	Cases	Per cent	Cases	Cases	Per cent
Acute cholecystitis	64		15	4		11
Subacute cholecystitis				6		
Acute hydrops			100	13	3	15
Acute empyema			100	30	6	20
Perforation of gall bladder	4	4	100			25
Gangrene				7	14	21
Total	64	14	25	7	14	21

may be for many patients were not operated upon as soon as they should have been. In no instance it seems to me was surgery instituted too early. No patient, however, was operated upon until at least 24 hours had elapsed since the onset of the acute attack.

There were 44 instances of undifferentiated acute cholecystitis not considered surgical and therefore treated medically. Four patients died a mortality of 9 per cent. Two of the deaths were due to peritonitis arising from gall bladder pathology more acute than was clinically expected. Autopsies were not performed upon the 2 other patients. On the surgical side in 11 patients with acute cholecystitis (i.e. acute exacerbation of chronic cholecystitis) were operated upon and there were 2 deaths, a mortality of 18 per cent. For comparative studies, 41 patients with less severe acute exacerbations of chronic cholecystitis (with or without stones) were treated medically without any deaths while 76 similar patients were operated upon with 3 deaths a mortality of 4 per cent an unduly high percentage.

In 11 cases of subacute cholecystitis medical treatment was instituted and there were 2 deaths (mortality 18 per cent) while 4 patients were operated upon with 1 death (mortality 25 per cent). In no case in which acute hydrops was diagnosed was medical treatment used but 6 such patients were operated upon without mortality.

There were 4 patients with acute empyema of the gall bladder who were treated medically. All of these patients died. Eighteen patients with acute empyema were operated upon and there were 3 deaths (mortality 16.6 per cent).

Four unrecognized perforations of the gall bladder occurred on the medical service with a mortality of one hundred per cent. Twenty perforated gall bladders were operated upon with 6 deaths (mortality 30 per cent).

In 1 instance of gangrenous cholecystitis secondary to carcinoma of the bile duct the patient died on the medical service. Twelve patients with diffuse or local gangrene were operated upon with 4 deaths, a mortality of 33 per cent. Eleven of the 42 patients operated upon for advanced acute cholecystitis died a total mortality of 25.6 per cent. All the deaths were due to peritonitis except in 1 patient who had an acute empyema of the gall bladder and died on the twelfth day after operation of parotitis and one who had a perforated gall bladder and died of pneumonia on the fourteenth day. The postoperative interval before death furnishes some concept of the seriousness of delay before surgery for practically all of the patients died of advanced peritonitis. One patient with a perforated gall bladder died a few hours after operation from peritonitis and shock. 1 with gangrene and 1 a perforated case each died the first day after operation of peritonitis. 1 with acute empyema. 1 with acute gangrene and 1 with perforation died the second day. 1 a perforated case died the fourth day. 1 with gangrene died the fifth day and 1 patient with a perforated gall bladder died on the fourteenth day of peritonitis. In most of these instances the peritonitis was fairly well advanced before the patient was operated upon.

It is evident from a perusal of this data that the severer grades of acute cholecystitis carry very high mortalities. Furthermore, what appears to be a mild or moderately severe cholecystic inflammation clinically may actually be fulminant. Though the operative mortality in advanced acute cholecystitis is great, it is considerably less than that which followed deferred or mistaken diagnoses. It is true that this statistical study is not large but it furnishes sufficient data for us to reconsider our methods of treatment in this disease. My point, and I cannot make it too earnestly is that advanced acute cholecystitis cannot be recog-

TABLE II —AGE AND SEX

Ages	Total	Males	Females
20-25	4	1	3
26-30	2		2
31-35	3		3
36-40	3	2	1
41-45	3	2	1
46-50	9	2	7
51-55	2		2
56-60	4	1	3
61-65	3	2	1
66-70	5	3	2
71-75	2	1	1
76-80		2	
81-85	1	1	
Total	43	17	26

TABLE III —SYMPTOMATOLOGY

Time	Duration of chronic symptoms				Duration of second	
	Colic	Indigestion	Vague	Jaundice	Acute symptoms	Acute attack
Denied	6	5			None	1
1-3 mos	2	2			Few hr	0
4-6 mos	4	2		1	12 hr	1
7-12 mos.	1	1			1 day	8
1-2 yrs.	5				1-3 days	9
2-4 yrs.	3	4		1	4-6 days	11
4-6 yrs	6		1		1-2 wks.	3
6-10 yrs	2				2-3 wks.	
Over 10 yrs.	2	1			More 3 wks	1

Acute symptoms Six of the 43 patients denied ever having had stomach distress of any sort. Two had had distress of less than 3 months' duration, the 35 remaining patients gave a history of suggestive or typical gall-bladder disease over relatively long periods of time (Table III). Only 2 of the patients, however, had been previously jaundiced.

nized in many instances even by the ablest physicians. Therefore, it seems to me that operative intervention should be undertaken earlier in every doubtful case. The statistics of other authors show that the operative mortality of acute cholecystitis need not be high (2, 4, 5, 6, 8, 10). Our own data indicates that we are probably too conservative in our treatment of this disease. Inasmuch as the surgeon is called in consultation by the clinician, I am making a plea, which is based upon these figures, for earlier surgical consultation.

A more detailed study of the severest cases may enhance our problem. From the series of 134 cases of acute cholecystitis, I have taken 43 consecutive operative cases of perforation, gangrene, or acute empyema for further consideration. There were 17 males and 26 females, ranging from 20 to 85 years of age as shown in Table II. The greatest number occurred between the ages of 45 and 50, although there was a surprisingly high percentage in the decade between 60 and 70. Two moderately severe instances of acute gangrenous cholecystitis developed in young persons aged 23 and 25.

Acute symptoms were denied by 1 patient, he maintained he had had no distress even immediately before surgery was instituted. Another elderly patient was under observation for 35 days in the hospital following two operative procedures for prostatic obstruction when he suddenly developed acute abdominal pain with marked physical signs of some abdominal catastrophe. Within a few hours he was operated upon with a tentative diagnosis of mesenteric thrombosis but a ruptured gall bladder was found. He must have had considerable pathology in his gall bladder long before perforation occurred, yet he gave no indication of any gall bladder disease in his history or during his 35 days in the hospital. One patient was operated upon for a strangulated femoral hernia, the hernia was present but not incarcerated. A ruptured gall bladder caused the acute abdominal symptoms. One patient was operated upon for a ruptured ulcer. His previous history was quite typical of chronic duodenal ulcer, but at operation an early gangrene of the gall bladder was found but no peptic ulcer. Only 1 patient had a history of acute onset 12 hours before exploration was instituted. This pa-

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TABLE IV—PHYSICAL SIGNS

Diagnosis	Pain	Indurated area	Tenderness	Rebound tenderness	Rigidity	Jaundice
Grade I		14	6	2	4	3
Grade II	5	3	5	10		
Grade III	5	3				
Grade IV (total)	5					
Recurrent M. S.	5					

tient recovered. Eight patients had distress for 1 day or less, and 1 patient had an exacerbation of acute cholecystitis signs for 1 day before operation was performed. The majority of the patients were observed from 1 to 6 days before operation was undertaken. This is in accord of course with the teaching at most medical schools of conservatism in the treatment of acute cholecystitis. Five patients were under observation between 2 and 3 weeks before surgery was performed. Six of the patients passed through one acute attack only to have a second a few days later. The majority of these occurred within a few days and probably therefore represent exacerbations of the same pathology.

A study of Tables IV, V and VI is pertinent for it further indicates how advanced the pathology of acute cholecystitis may be before adequate signs are present for its recognition. Eleven of the 20 cases of ruptured gall bladders were kept under observation from 5 to 30 days before surgery was performed. Nine of these are all the more significant when we remember that these patients were in a teaching hospital where several of the staff were in attendance. Even so the pathology had advanced far beyond the clinical appreciation of the state of the disease. The point I am trying to emphasize is that even when we may be anticipating advanced pathology it can be present without recognition.

Pain. An analysis of the distress caused by is rather surprising for the degree of these advanced lesions did not seem commensurate in many instances with the degree of pathology present (Table IV). Two patients denied abdominal pain or discomfort. One of these had a ruptured gall bladder with peri-

tonitis which caused her death. The other had a gangrenous gall bladder. Four patients had mild or indefinitely located discomfort. 2 of these had ruptured gall bladders, 1 had an acute empyema and 1 had a large ordermatous and acutely inflamed gall bladder. Only 5 patients had typical colic with their present illness and only 5 others required opiates for relief. The remainder had characteristic gall-bladder pain of moderate or severe grade. The majority of patients localized their distress to the right upper quadrant (Table V). One had pain only in the left upper quadrant and in 2 patients diagnosis was made and the patients operated upon for acute appendicitis because of right lower quadrant localization.

Indigestion. Five patients denied any history of previous gastro-intestinal distress. 3 gave a history of indigestion only with the present illness and denied any previous trouble. The majority however had had typical gall-bladder indigestion of many years standing. Vomiting was absent in 11 of the 43 patients.

Tenderness. The physical signs were of much greater aid in diagnosing the acute lesion in most of these patients, although in many the signs were so indefinite and vague that the diagnosis of acute trouble was overlooked (Table IV). Three patients had no localized abdominal tenderness, and 5 had only mild grades of local or diffuse tenderness. In the former group 1 patient had an acute excision of the gall bladder. 1 had an acute exacerbation of chronic empyema with free pus in the peritoneal cavity and the third had a recent acutely inflamed empyema. The majority of the patients, however, had definite right upper quadrant tenderness with positive Murphy maneuvers. In the latter group, 1 patient had a large femoral hernia which was considered incarcerated. The hernia was not strangulated and the acute abdominal condition was found due to bile peritonitis secondary to a ruptured gall bladder.

Jaundice. Jaundice, as determined clinically was absent in 30 of the 43 patients. This was quite surprising, inasmuch as we have been led to believe it frequently accompanies acute cholecystitis.

TABLE V—LOCALIZATION OF PAIN

Localization	Cases	Mass
Diffuse	5	Present 12
R. U. Q.	10	Absent 13
L. U. Q.	1	
R. L. Q.	2	
Shoulder	1	
Back	1	

Rigidity Local rigidity was totally absent in 2 of the patients and only suggestive rigidity was noted in 6. In the former, 1 patient had a gangrenous gall bladder without stones secondary to carcinoma of the gall bladder, and the other had a perforation with a deep-seated local abscess at the neck of the gall bladder. Most of the patients, however, had very frank local or general rigidity. A mass was palpable in 12 of the patients and noted as absent in 13.

Fever The fever chart probably offered the most surprising data (Table VI). Six of the patients had normal temperatures during the hospitalization period before surgery. One of these had normal temperatures every 4 hours for 5 days, yet at operation free bile was found in the peritoneal cavity from a perforation of the gall bladder. One patient's fever chart for 3 weeks was normal, yet at operation a perforated gall bladder with an abscess containing 5 stones was found between the liver and the gall bladder. One patient had but a single temperature recording, that was 97, and a ruptured gall bladder and general peritonitis were found. One patient had a temperature of 98 to 98.6 degrees for 12 days, yet at operation perforation of the gall bladder with free bile in the peritoneal cavity was found. Another patient had a temperature of 99.6 degrees on the day of entrance into the hospital, the next day it was normal and remained so for 10 days, yet at operation she had a perforated gall bladder with a large local abscess containing a stone between the neck of the gall bladder and the duodenum. The sixth patient had a temperature of 98.8 degrees, yet at operation 10 hours later he had

TABLE VI—FEVER AND WHITE COUNT

Temperature	Cases	W. B. C.	Cases	Differential	Cases
98.6	6	8500-10000	5	6-65	1
99	7	10000-11000	1	65-70	0
99-100	15	11000-12000	3	70-75	2
100-101	3	12000-13000	2	75-80	8
101-10	3	13000-14000	0	80-85	12
102-103	4	14000-15000	2	85-90	11
103-104	5	15000-16000	1	90-95	8
		16000-17000	7		
		17000-18000	4		
		18000-20000	7		
		20000-25000	6		
		25000-30000	3		
		30000-40000	1		

a gangrenous gall bladder with a perforation and free bile in the abdominal cavity. Several of the patients with ruptured gall bladders had fevers less than 100 degrees. The patients with acute empyema of the bladder, as a rule, had the highest and most constant fevers. The fever graphs, however, were less elevated than might be expected, especially in the cases in which perforation or localized gangrene were present.

White count The polymorphonuclear white cells gave the best laboratory indication of acute inflammatory disease (Table VI). A majority of these patients had a white count of over 16,000. Only 5 were below 10,000. These included three perforations, a gangrene, and an acute empyema. The differential count was also high, although not as definitely indicative as the total white count. One patient who had a perforated gall bladder with a walled-off abscess had a polymorphonuclear count of only 62 per cent, 1 with an acute empyema had a 73 per cent differential, while another ruptured gall bladder had 74 per cent as the highest count during his 12 day period of observation in the hospital. Some of these low counts, however, may not represent the true picture, for only two or three counts were taken during a week's observation, patients operated upon a few hours after entrance into the hospital had only a single count recorded.

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TABLE VII.—OPERATIVE MORTALITY STATISTICS

	With out stomach stomach	With- out stomach
Acute pathology	17	6
Perforation		
Gangrene		
Acute empyema		
Cholecystectomy		
Perforation	4	
Gangrene	9	
Acute empyema		
Cholecystectomy		
Perforation	13	6
Gangrene	2	
Acute empyema	4	
Operation—number of days after onset of pre- sent illness		
to 4 days	5	1
Perforation	1	
Gangrene		
Acute empyema		
to 7 days		
Perforation		
Gangrene		
Acute empyema		
to 10 days	20	
Perforation	1	
Gangrene		
Acute empyema		
Operation—hours after entrance to hospital		
to 24 hours	7	1
Perforation	2	
Gangrene	5	
Acute empyema		
24 hours or more	20	1
Perforation		
Gangrene		
Acute empyema		

The classical clinical picture of acute cholecystitis is represented by the patient who has a history of severe epigastric or right upper quadrant pain of 3 or 4 days duration radiating posteriorly and to the right shoulder with vomiting, local gall-bladder tenderness, and abdominal rigidity high fever and markedly increased leucocytosis, with possible jaundice. Only 1 of the 43 patients had all of these classical signs. Eleven of the 43 presented all the signs except jaundice (25 per cent). Six patients had all these signs except jaundice, vomiting and fever and 1 also lacked increased white counts. One patient had all but fever and an increased white count, but 4 patients lacked vomiting as well as fever and abnormal leucocyte counts. The first of these patients had a ruptured gall bladder with bile peritonitis. Three of the latter were perforations and 1 had gangrene of the gall bladder. Of the 17 remaining patients all had increased white counts but were lacking in either fever vomiting, rigidity or severe pain. The majority of the patients therefore lacked one or more of the cardinal

signs of an acute inflammatory biliary lesion.

Table VII showing the period of observation in the hospital before surgery was undertaken demonstrates the conservative tendency of the operating staff. Twenty-one patients of the operating staff were observed for more than 5 days before operation was performed. However it must be remembered that in some of these patients even the diagnosis was not established much less the stage of the acute pathology. Fifteen patients were operated upon within 6 hours after entrance into the hospital. These patients had most of the classical signs of an acute abdomen although 3 were operated upon for other acute abdominal lesions and gall bladder pathology was not suspected. Sixty per cent of the patients having perforated gall bladders operated upon within 4 days after the onset of their acute cholecystitis disease died. 100 per cent of those (only 1 number) operated upon from 4 to 7 days and 10 per cent of those operated upon later than 1 week died. Thirty three per cent of the patients with acute empyema operated upon within 4 days died whereas no mortality occurred in those operated upon more than 1 week after the onset of their present illness. Those statistics would seem to indicate that delayed surgery in acute cholecystitis offers the better prognosis. It is from such data that the popular conservative attitude has arisen. Unfortunately these statistics fail to show that pathology and not the time interval is the vital problem. When our tables are analyzed from this point of view we find that patients with acute perforations and gangrene causing general peritonitis must be operated upon very early. The acute perforations on the liver side of the gall bladder and those that are immediately walled off by omentum may be operated upon later but in the present state of our knowledge we apparently cannot diagnose a perforation from a gangrene or an acute empyema, much less could we anticipate the site of a perforation or its likelihood of being walled-off.

In the patients who had perforated gall bladders and were operated upon a week or more after the onset of their acute symptoms, the relatively low mortality of 10 per cent occurred in those who had walled-off perfora-

tions Obviously the perforation was slow enough to permit adhesions to wall off the perforating site Operation might have been instituted at any stage in the walling-off process with equal security Do we wait for acute appendicitis to wall off? Is the mortality better in perforated or non-perforated appendicitis? The answer, of course, is that early surgery in non-perforated and late intervention in perforated appendicitis is best And so, indeed, our statistics prove true for acute cholecystitis Our difficulty lies not in the type of pathology we find after the gall bladder has been operated upon, but rather in what stage shall we operate And our present study has shown that we are unable to determine before operation what state of pathology, or often even what kind of pathology is present So we wait, hoping for localization If it does not occur, mortality is extremely high If it has occurred, operative mortality is low But the risk of waiting is greater than the risk of early intervention

Cholecystectomy was performed in 21 cases with 2 deaths, a mortality of approximately 10 per cent Cholecystostomy was done in 20 instances with 9 deaths, a mortality of 45 per cent All the patients had advanced, acute, gall-bladder pathology There were 19 perforated gall bladders, 11 acute local or diffuse gangrenes, and 12 acute empyemas of the gall bladder An analysis of the operative deaths shows that 3 of the 11 patients with gangrene (mortality 27 per cent), 6 of the 18 with perforations (mortality 33 per cent), and 2 of the 12 with acute empyema (mortality 17 per cent) died Acute abdominal lesions were recognized clinically but not in terms of pathology in 3 patients with gangrene, in 6 with perforations, and in 1 with acute empyema who died

From this study it is evident that our ability to determine clinically the type or stage of acute cholecystic pathology is not well developed We are justified in watchful waiting, hoping for localization of the acute inflammatory process only under the most favorable circumstances, with hospitalization, adequate nursing, interne, and laboratory facilities When an acute abdomen of suspected gall-bladder origin is present, exploration should

not be delayed too long The operative risk is less than that of watchful waiting for the mortality from late complications is greater than the mortality of early surgery Surgical opinion is swinging toward earlier exploration in acute cholecystitis and statistical studies seem to warrant this course Improvements in pre-operative and postoperative care and better types of anaesthesia are undoubtedly the reasons for this recent lowered mortality

My present study, though it covers a relatively small series of cases, indicates that a change from the earlier policy of delayed investigation is warranted I have previously felt that our attitude should be conservative in acute cholecystitis except in cases of gangrene But from recent experiences and those of others recorded herein it is evident that we are unable to detect clinically acute gangrene, perforation, or even empyema of the gall bladder with sufficient accuracy Patients who we believe have an acute empyema later prove to be suffering from gangrene or perforation We pursue the policy of watchful waiting with the hope that the acute inflammatory reaction will subside or localize When finally forced to operate we find to our chagrin that peritonitis is already present The recent statistics of surgeons who have explored these cases earlier are indeed better than our own Since I have become bolder my mortality has also decreased None of the few (9 only) cases of acute empyema in which I have performed early cholecystectomy have died This is in accord with the experiences of Fowler, Graham, Santee, Estes, and Hayes I believe that the future studies of others will uphold the contention of these writers in advocating earlier surgical consultation and laparotomy in cases of suspected acute cholecystitis

SUMMARY

- 1 The pathology present in acute cholecystitis cannot be adequately evaluated clinically

- 2 Exploratory laparotomy should be instituted earlier in suspected cases of advanced acute cholecystitis

- 3 Perforations and gangrene of the gall bladder occur more frequently than is usually believed

4. Acute empyema of the gall bladder is best treated by conservative surgery (i.e. cholecystostomy)

5. Perforations and gangrene warrant early cholecystectomy

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POSTOPERATIVE PULMONARY COMPLICATIONS

E. L. ELLISON, M.D. F.A.C.S. AND CHARLES McLAUGHLIN, M.D. PHILADELPHIA

From Surgical Service C, Department of Surgery, University of Pennsylvania Hospital

PULMONARY complications have always existed as a very real problem in the post-operative management of the surgical patient. The early literature on the subject of anesthesia in relation to surgery has in it little or no comment regarding the incidence of pulmonary complications probably because of the short anesthesia and the speed in which the surgical procedures of the day were performed, together with failure to diagnose the condition as existing.

Pulmonary disease has been found to occur in from 1.5 to 5.5 per cent of all postoperative cases with a resultant general mortality of from 0.3 per cent to 0.7 per cent which can be definitely ascribed to the pulmonary complication. When one realizes that approximately one in every two hundred patients submitted to surgery will succumb directly as a result of a pulmonary complication, the great importance of this subject becomes apparent. On this basis we have undertaken a critical analysis of all the postoperative pulmonary complications occurring on Service C, of the Hospital of the University of Pennsylvania during the past 9 years, in the hope of obtaining information which will enable us more successfully to combat them. These statistics have been taken from this one service of this one hospital rather than from more than one in order that constant factors of housing, clothing, heating, surgical care technique, etc. would obtain.

The inherent fallacy of a statistical study is well known and appreciated. To minimize this error an accurate definition of what is considered a post-operative pulmonary complication becomes neces-

sary. On Service C any patient who manifests any abnormal postoperative temperature reaction, or who continues to run an unusual elevated temperature for a period longer than the 3 or 4 days associated with the postoperative reaction, is studied carefully by all available means to ascertain the presence of pulmonary pathology. All patients who demonstrated evidence of a pulmonary lesion either to physical examination or to roentgenological study are included in the group. If such findings are elicited between time of operation and discharge from surgical service.

From September 1922 to September, 1931, there were 7,346 operations performed on Surgical Service C, and these form the basis of this study. These operations were all general surgical procedures and do not include gynecological, urological, neurosurgical, or otolaryngological surgery. In this series 130 proved postoperative pulmonary complications occurred, and in 39 of them death occurred. This represents a morbidity of 1.63 per cent and a general mortality from pulmonary complications of 0.54 per cent. It will be interesting to note that the general mortality as well as the incidence of pulmonary mortality and morbidity has undergone a gradual reduction during the last 5 years (Table I).

During this same period of observation, 28,663 operations were performed on the entire surgical service of the University of Pennsylvania Hospital exclusive of the departments of gynecology, orthopedics, and otolaryngology. In this entire series the morbidity from postoperative pulmonary complications was 1.38 per cent.

TABLE I.—MORTALITY STATISTICS, SERVICE C, 1922-1931

Year	Operations	Operative deaths, all causes	Operative deaths, all causes %	Pulmonary complications	Fatalities pulmonary complications	Morbidity %	Mortality from pulmonary complications %	Mortality of morbidity %
1922-23	66	31	4.95	17	7	2.71	1.11	41
1923-24	891	31	3.5	9	5	1.01	0.56	55
1924-25	871	36	4.1	20	4	2.29	0.45	20
1925-26	932	34	3.65	18	3	2.13	0.32	16
1926-27	784	32	4.08	7	3	0.89	0.38	42
1927-28	806	19	2.35	24	6	2.97	0.74	25
1928-29	782	24	3.06	10	4	1.27	0.51	40
1929-30	792	28	3.53	10	4	1.27	0.50	40
1930-31	842	16	1.9	5	3	0.59	0.35	60
	7326	251	3.37	100	39	1.68	0.54	32.5

Pulmonary complications occurring during the postoperative period have a high mortality rate in practically all series. In these 7,326 cases in which operation was done, there was a total operative mortality of 251 cases, or 3.42 per cent. Of the 120 cases of postoperative pulmonary complications, 39 patients, or 32.5 per cent, died. Postmortem examinations were made in 15 of the 39 fatal cases. It is thus apparent that 15.5 per cent of the total operative mortality could be attributed either partially or entirely to the postoperative pulmonary complication, and in 21 fatal cases, or 8.35 per cent, the death was entirely attributed to the pulmonary lesion. It is chiefly in the reduction of this latter group that the prophylaxis of pulmonary complications has its great place.

The incidence of postoperative pulmonary complication has been found to vary by the different authors reporting series in the literature. It is interesting to note that those men who have reported their series annually report an increasing morbidity with a corresponding fall in mortality. This is probably the result of a very diligent search of the available material for the occurrence of pulmonary complications and the more frequent recognition of small areas of lobular atelectasis during the early postoperative period.

For many years the factors concerned in the causation of pulmonary complications have been the subject of discussion among surgeons. Two schools eventually developed in the controversy. The first, lead by Cutler, attributed the pulmonary lesion to emboli and infarction due to trauma at the operative site, while the second school considered aspiration of infected material to be the mode of production. The essential facts in favor of the aspiration theory are as follows: (1) Ex-

perimentally and clinically, material from the mouth may gain access to the trachea and lungs during anaesthesia. (2) In animals under ether, colored matter in the stomach may reach the lungs if the animal is allowed to vomit. (3) The pneumococcus type IV is responsible for the majority of postoperative pulmonary complications and it is well known to be a common organism in oral secretions. (4) Pre-existing lung lesions frequently flare up with anaesthesia. The chief arguments advanced by Cutler in favor of the embolic theory are: (1) Complications occur frequently in the hands of skilled anaesthetists. (2) They occur after local and spinal anaesthesia. (3) Fact that such a small proportion of those patients taking ether get a postoperative lung lesion. (4) Oral hygiene seems to play but a small part in the occurrence of these lesions. (5) Lymphatic and vascular channels leading to the lungs offer an ideal anatomical route for emboli to travel. (6) Abrupt onset suggests an embolic onset. (7) Emboli are occasionally found plugging branches of the pulmonary arteries in fatal cases.

Obviously there were many difficulties encountered in attempting to explain these complications entirely by either theory.

In 1890, William Pasteur first described a condition which he called massive collapse of the

TABLE II.—PULMONARY COMPLICATIONS ON SERVICE C AND ENTIRE SURGICAL SERVICE

	Entire surgical service	Service C
Total cases 1922-1931	22,962	7,326
Total pulmonary complications	317	120
Total number fatalities from pulmonary complications		
Morbidity—pulmonary complications	1.38%	3.9%
Mortality—pulmonary complications		0.54%
Mortality of morbidity		32.5%

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TABLE III.—INCIDENCE OF PULMONARY COMPLICATIONS AS REPORTED BY VARIOUS AUTHORS

Author	Year	Operation	Number pulmonary complications	Mortality %	Number fatal cases	Mortality %	Mortality of anastomosis %
Johnson	1894	5,674	23	36	23	46	62
Acronberg	1901	1,000		23			
Johnson	1909	1,000	43	66			
Johnson	1913	1,800	87	66			
Walsby	1913	2,776	61	1	25	67	75.7
Walsby	1914	2,900					
Walsby	1915	1,413					
Coffey	1918	2,776	99	1.06	11	7	7.9
Johnson and Gage	1918	2,776		2.51	5		63
Walsby	1918	2,643	55	3.56	10	3	
McKenna (Combined statistics)	1919	1,664	61				
Coffey	1920	1,804	64	3.56	6		75
Coffey	1920	1,876		7	10	9	53
Decker	1921	2,373	16	19	9	9	16
Coffey	1921	2,373	16	3.9	9	7	41
Decker	1922	1,000	10	2	12	1	10.1
Boys	1923	1,000	41				
Cook and Phillips	1924	1,511	60				
Boys	1926	1,413	100				
Pear and Kopp	1927	1,776	100				
Johnson and McLaughlin	1927	1,776	100				

lung. This was much further studied by Sir J. Rose-Bradford during the late war and was especially brought to the attention of American surgeons by Scrimger in 1921. Since then the subject of massive collapse in the lobar and lobular forms has been extensively investigated and the literature contains many articles on the subject. Numerous explanations have been offered to explain this lesion. Pasteur and Rose-Bradford consider it the result of a reflex mechanism affecting the intercostal muscles with a subsequent absorption of air. Henderson considers it due to hyperventilation plus bronchial obstruction. Conly, Mathes and Holman, Lund and Retvo, Brown, Hirschboeck and Elliot and Dingy consider the primary cause to be bronchial obstruction resultant from inspissated secretion. Recently Muller Overholt, and Pendergrass have offered convincing evidence that a high diaphragm with loss of its normal pumping action is the primary cause of the collapse while the bronchial obstruction is considered secondary. They found that following upper abdominal operations thoracic expansion was reduced 79 per cent and diaphragmatic excursion was decreased 66 per cent with a resultant loss of 75 per cent in lung capacity. They further showed that 70 per cent of a

series of patients examined by X-ray the first day following upper abdominal operations showed an elevated diaphragm with increased trunk shadows interpreted as being the first step in the development of a lobular collapse. These studies essentially substantiate those of Churchill and McNeill, who found that following upper abdominal operations the vital capacity was reduced 50 to 88 per cent of the normal with an incidence of pneumonia approaching 5 per cent. In lower abdominal operations the vital capacity was reduced 30 to 75 per cent, with an incidence of pneumonia of 0.75 per cent. Following operations on the head, vital capacity was but little interfered with and pneumonia occurred in 0.3 per cent or less of the cases.

These and other studies have led to a somewhat different conception of the origin of postoperative pulmonary complications. Clinical and experimental evidence indicates that areas of lobular collapse with or without symptoms in the upper abdomen occur in a large proportion of postoperative cases, especially following laparotomy in the upper abdomen. If the affected area be sufficiently large symptoms are usually apparent. If the area be small and not infected, it tends to recover spontaneously. If however these atelectatic

TABLE IV—CLASSIFICATION OF PULMONARY COMPLICATIONS AS TO TYPE OF LESION

Year	1922-23	1923-24	1924-25	1925-26	1926-27	1927-28	1928-29	1929-30	1930-31
Operations performed	626	891	871	932	784	806	782	793	842
Pulmonary complications	17	9	20	18	7	24	10	10	5
Deaths from pulmonary complications	7	5	4	3	3	6	4	4	3
Mortality of morbidity	41%	55%	20%	16%	42%	25%	40%	40%	60%
Lobar pneumonia	0	4	4	3	2	3	0	2	0
Bronchopneumonia	7	2	10	9	2	4	4	3	1
Massive collapse	0	0	3	0	0	8	5	5	2
Bronchitis	5	2	3	3	0	1	0	1	1
Pleurisy	1	0	1	1	1	5	1	0	0
Pulmonary embolism and infarct	3	0	0	1	2	1	0	1	1
Lung abscess	0	1	0	0	0	0	1	0	0
Hypostatic pneumonia	1	0	0	0	0	0	0	0	0
Tuberculosis	0	1	0	0	0	0	0	0	0
Pneumothorax	0	1	0	0	0	0	0	0	0
Empyema	0	0	0	1	0	1	0	0	0

areas become infected from an existing bronchitis, aspirated oral secretion, or by septic emboli, the picture becomes that of a postoperative bronchopneumonia or lobar pneumonia, depending upon the size of the involved area and the virulence of the infecting organisms. Such a conception of postoperative pulmonary pathology is outlined by Coryllos, Henderson, and Elwyn, who essentially identified postoperative bronchitis, atelectasis, bronchopneumonia, and possibly abscess as different stages of the same process (Table IV).

The presence of infection at the time of operation, either in the operative site or in the respiratory passages, materially increases the possibility of postoperative pulmonary complications. In our series of 120 cases, 19 had colds or chest signs at the time of operation. All but 5 of these were acute surgical emergencies or septic cases and immediate surgery was required. Of these 19 patients with respiratory infection, 6 succumbed directly as a result of their respiratory complication and 4 others died, the pulmonary complication being a contributing factor in causing death. Joslin and Gage report that 10 per cent of their series of pulmonary complications gave a history of having had a recent respiratory infection. Whipple reports that 21 of his series of 97 cases had colds at the time of operation. Elwyn found a history of a recent cold or bronchitis in 25 per cent of his series of 89 cases and similar findings were noted in 13 of 69 cases of pulmonary complications reported by Cutler and Hunt. Whipple found that type IV pneumococcus was present in

the sputum both before and after operation in a group of cases that developed postoperative pulmonary complications, and he considers that this is the usual organism responsible for the infection in the lung.

In our series, 55 of the 120 cases came to operation as acute surgical emergencies and 41 of the cases are listed as septic, pus being present at the operative site.

Bronchopneumonia was the most common complication, being observed in 45 cases. Atelectasis was noted 23 times, lobar pneumonia 18 times, and embolism and infarction 9 times. The lower lobes were the ones most commonly affected and the right lower lobe appeared to suffer more frequently than the left. In our series the right chest was the one affected in 39 cases, the left in 19, and in the remaining 69 cases the lesion was either bilateral or the side affected was not stated.

The rôle of anesthesia in the etiology of postoperative pulmonary complications has been an interesting one. When the administration of inhalation anesthesia had become a standard procedure pulmonary complications were promptly attributed to the anesthetic and the term "ether pneumonia" became a familiar one. Pasteur was one of the first to attack this idea in an attempt to free the anesthetist from the stigma of the postoperative pulmonary complication. In recent years with the use of a wide variety of anesthetics, it is apparent that pulmonary complications do occur regardless of the type of anesthetic agent and the mode of administration. A study of the

TABLE V.—INCIDENCE OF PULMONARY COMPLICATIONS WITH VARIOUS TYPES OF ANÆSTHESIA

	Breath- er-mem.	Other mem- em.	Sponta- neous mem- em.	Muscle relax- ants	Acute bronchitis	Pneum- onia	Lung abscess	Emphyse- ma	Tuber- culosis	Pulmo- nary infarct or infarct	Total complica- tions according to anaes- thetic
Drop ether	9			6	7					2	29
Intratracheal ether											3
Ether (through machine)											3
Nitrous oxide gas-ether	24										24
Nitrous oxide gas											30
Nitrous oxide gas-local	3										3
Local	6	3									24
Spinal ether											
Spinal				3							7
Spinal-ether											1
Spinal-ether and nitrous oxide gas											
Ethylene											3
Ethylene ether											
No anaesthesia											
Total—type of complications	24	12		21	17	6				6	

anæsthetic charts of each of our 120 cases shows that in only 13 instances the anaesthetist noted that the patient took the anaesthetic poorly or that the anaesthetic was a particularly difficult one. The 98 remaining cases are listed as smooth and uneventful. Nitrous oxide gas-ether was the anaesthetic combination most frequently followed by pulmonary lesions in this series, with open drop ether second, and local anaesthesia third.

Lowen in the Leipzig Clinic found pulmonary complications more frequent following local anaesthesia in abdominal operations and Mikolice found the percentage of pulmonary complications relatively greater following local anaesthesia. Elwyn reports the morbidity of postoperative pulmonary complications as 4.3 per cent in a series of hernias done under general anaesthesia and 8.1 per cent in a series done under local anaesthesia. Cantler found the incidence of pulmonary complications following laparotomy to be the same with

local and general anaesthesia but the incidence was less following operations on the head and neck in a series in which local anaesthesia was employed. Brown contends that the incidence of atelectasis is higher in those cases in which spinal is used instead of regional or inhalation anaesthesia. Foss and Knapp in a series of 400 consecutive laparotomies done under spinal anaesthesia, report the incidence of pulmonary complications to be 1.7 per cent which is identical with the morbidity in a series which they previously reported in which inhalation anaesthesia was used (Table V).

That the length of the anaesthesia has a definite bearing on the number of pulmonary complications, there can be no doubt. In the early days of anaesthesia, surgeons were accustomed to look upon the anaesthetic agent as a poison, and it was deemed advisable to complete the operative procedure with the maximum expediency in order to reduce the anaesthetic period. While the quality of anaesthetic agents and the technique of administration have been greatly improved, examination of Table VI shows that by far the greatest number of complications occur in those operations extending over the 30 minute period. It would, therefore, seem that reduction of the anaesthetic period to the shortest possible time would serve as an important prophylactic measure in preventing pulmonary complications.

TABLE VI.—DURATION OF ANÆSTHESIA AND INCIDENCE OF PULMONARY COMPLICATIONS

Duration of anaesthesia	Cases
0 to 15 minutes	5
15 to 30 minutes	3
30 minutes to 1 hour	11
1 hour to 1½ hours	30
1½ to 2 hours	3
2 hours to 3 hours	9

TABLE VII—COMPLICATIONS AFTER OPERATIONS ON VARIOUS PARTS OF BODY*

Operations on	Total pulmonary complications	Mortality (all cases with pulmonary complications)	Pulmonary complications responsible for death	Pulmonary complications contributing factor	Patients with elevated temperature pulse, and respiration at operation	Septic cases	Cases with colic or pulmonary complications before operation	Clean cases (normal temperature, pulse, and respiration), no infection in operative site	Emergency cases—acute (operated on admission)	Non emergency cases	Per cent mortality of morbidity (entire)	Per cent mortality of morbidity (absolute)
Appendix	35	6	2	4	24	14	8	19	26	9	17.1	5.7
Small intestine	21	3	2	1	5	5	2	14	6	15	14.3	9.5
Hernia—inguinal and femoral	15	2	2		2	2	2	11	4	11	13.3	13.3
Stomach†	4	2		2	1	1	0	3	1	3	50	0
Biliary tract	18	6	4	2	7	7	3	10	6	12	33.3	22.2
Intestinal obstruction	1	0	0	0	0	0	0	1	0	1	0	0
Lower extremity	10	8	5	3	5	5	1	2	6	4	80	50
Upper extremity	2	2	0	1	0	1	0	1	0	0	100	0
Head	1	1	1	0	1	0	1	0	0	1	100	100
Chest and breast	3	3		1	0	2	0	1	1	2	100	0
Kidney	1	1	1		0	0	0	1	0	1	100	100
Spleen	1	1	1		1	0	0	1	0	1	100	100
Hernia—umbilical and incisional	2	1	1		0	0	2	1	1	1	50	50
Prostate	1	1	1		0	0	0	1	0	1	100	100
Rectum and anus	1	0	0	0	0	0	0	1	0	1	0	0
Pancreas	3	1	0	1	2	2	0	1	2	1	33.3	0
Mediastinum	1	1	1	0	0	1	0	1	0	2	50	50

*Septic cases in this table mean that a definite infectious process was present and all cases of appendicitis required drainage.
†Exclusive of gastro-enterostomies which are included under small intestines.

It has long been recognized that abdominal surgery is the type most frequently followed by pulmonary complications and those operations near the diaphragm are especially prone to cause chest lesions. In our series appendectomy was followed by the greatest total number of pulmonary complications, with operations on the duodenum and jejunum, stomach, liver and gall bladder, and inguinal and femoral herniorrhaphy closely following. In Table VII may be seen a tabulation of the complications following operations on various regions of the body.

These findings agree essentially with those reported by other men writing on the subject. Joslin and Gage found that 75 per cent of their pulmonary complications followed abdominal operations. Elwyn reports a morbidity of 6.2 per cent in 1,080 laparotomies with an incidence of 10.5 per cent in his gastric cases. Featherstone reports a morbidity of 10.8 per cent in 222 gastric operations as compared with 1.8 per cent in 110

hysterectomies. Sise *et al* found the morbidity of pulmonary complications to be 14.8 per cent following gastric operations and 5.9 per cent following biliary surgery.

That the type of upper abdominal incision employed may have a definite bearing on the post-operative course is suggested by the experience of the senior author during the past years. Recently a midline incision has been employed for all gastric and duodenal surgery instead of the right rectus or paramedian incision previously employed. Since this change was made, not only has the patient been more comfortable after operation and his convalescence been more smooth, but it is the impression that there is less splinting of the upper abdomen and diaphragm with this incision which may serve in part to prevent postoperative hyperventilation and its sequela.

For the purpose of comparing the incidence of pulmonary complications in general surgery with that occurring in other branches of surgery, we

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were permitted to review the incidence of such complications seen on the neurosurgical service, the thyroid service, the gynecological service, and the obstetrical service of the University of Pennsylvania Hospital. In 1,401 neurosurgical procedures undertaken during the past 4 years postoperative pulmonary complications have occurred 28 times, a morbidity of 1.99 per cent. Sixteen of these followed operations for prefrontal lesions, 7 operations for subdural lesions, and 5 operations on the spinal cord. In a series of 889 thyroidectomies performed during the past 4 years postoperative pulmonary complications were noted 6 times, a morbidity of 0.67 per cent. In 4 of these complications followed operations upon toxic thyroids, and in 2 upon non-toxic thyroids.

In 9,011 operative procedures since 1923 pulmonary complications have been observed 89 times, a morbidity of 0.97 per cent. While bronchopneumonia was the most common pulmonary complication occurring on the thyroid and neurosurgical services, as it is on the general surgical service pleurisy was the most frequent pulmonary lesion on the gynecological service, with bronchitis second and bronchopneumonia third. In the last 5,000 cases in the obstetrical department in which operative procedures were carried out, the incidence of pulmonary complications were 1.63 per cent.

It has been stated that postoperative pulmonary complications occur more frequently in those patients who are returned from the operating room with a low blood pressure and this group is also said to develop postoperative phlebitis with greater frequency than those patients who maintain their normal blood pressure. An analysis of our series fails to disclose evidence to support this observation. In our 120 cases, the blood pressure, throughout the operative procedure, was maintained in the majority at or near the pre-operative figure. There was no apparent tendency to develop phlebitis with low blood pressure readings to develop pulmonary complications. In the 120 cases, only 1 developed an associated phlebitis. Among the 9,011 operations reviewed on the gynecological service phlebitis occurred 54 times and in 3 cases the phlebitis was associated with a pulmonary complication. Foss and Kupp observed a phlebitis occurring with a pulmonary complication in 3 of their series of 60 cases. In each instance, the pulmonary lesion was the result of an infarct, usually multiple in type.

In the series now being reported, morphine has been used routinely to control the pain of the patient after operation. In addition, the patient is

given a preliminary dose, depending upon his size and weight, before going to the operating room, regardless of the type of anesthesia to be given. Examination of the records of these patients which developed postoperative pulmonary complications fails to show that they received amounts of morphine in excess of that usually given the patient after operation. The comfort that is given the restless patient after operation when his pain is controlled and he is able to rest, and breathe without fear of pain, more than outweighs the possible danger of decreasing the patient's respirations to a serious extent. This can be accomplished with amounts of morphine in the average patient that will not render him stuporous and unco-operative. It may be noted that Mathes and Holman, in a recent article, advise against the use of morphine after operation except in minimal doses, suggesting the use of 40 to 80 grains of sodium bromide in tap water by bowel to control pain. The efficacy of bromides to control real pain, however is still questionable.

Undoubtedly the use of the Gatch bed for the maintenance of a semi Fowler position for the patient who has had an abdominal operation has been a great factor in decreasing the incidence of postoperative pulmonary complications. By placing these patients in a position that decreases as much as possible the tendency to hypostatic congestion and allows more complete expansion of the lungs, the dangers incident to committing a patient to bed for a period of days are lessened. It is well to remember, however, that the semi Fowler position may be to the patient more of a curse than a boon. In the average hospital all Fowler springs are of one or at best two sizes. Hence we have the picture of the small young adult returned from the operating room and placed in a semi Fowler bed designed for a man of 6 feet or over. The young patient slowly gravitates down in bed until the pressure exerted on his upper calf muscles by the lower break in the bed soon becomes intolerable and he attempts to compensate for this misfit by sliding farther down in bed. In doing this the pressure on his calves is relieved and his knees assume the correct position in relation to the lower bend of the bed. This, however is accomplished at the expense of his back, the small part of which is now suspended in midair while his buttocks rest on one slope of the bed and his lower chest posteriorly on the other. In this position the patient slumps down, his chest restricted and compressed, his breath shall-

low and short, and his whole attitude one of misery. Disregarding all but the pulmonary element with which we are chiefly concerned, it is obvious that such a patient has been placed in the optimum position to embarrass respiration and promote pulmonary hypoventilation. If these simple things are kept in mind and the bed made to fit the patient by means of pillows and blankets, the patient's convalescence will be not only more pleasant but will tend to be freer from unfortunate pulmonary complications.

Tabulation of our cases according to age shows that 60 per cent of respiratory complications occur in patients between 20 to 50 years, 54 per cent occurring in those patients past 40 years of age. Pulmonary complications in the group of patients below 20 were rare on our service, the majority occurring in those during middle life.

The greater percentage of our complications occurred following operations during the months of November, December, January, February, and March, with a second peak in May. There was then a relative infrequency of occurrence until the following winter months.

These findings are similar to those reported by Featherstone, Rucker, and Cutler *et al*. Joslin and Gage found their series of 485 cases rather evenly divided as to months but their cases were all taken from those observed in the army during 1918 and can scarcely be compared with the larger series reported from civil practice.

Seventy per cent of our series occurred in male patients. While in general, pneumonia is reported to occur more frequently in men than in women, there is apparently a much greater incidence of postoperative pulmonary complications in surgery on male subjects. Exposure to which many men are subjected in their work and the greater incidence of gastric and duodenal lesions in the male may be factors partially responsible for this difference. Rucker and Sise *et al* both report a greater incidence in the male while Featherstone found the ratio of males to females to be 3:1 in his series. These facts can best be explained by the greater embarrassment to the normal abdominal and diaphragmatic respiration in the male following laparotomy while the female with costal respiration is less handicapped by the operative procedure (Chart 1).

As previously stated in this discussion, it is the custom on our service to consider any abnormal temperature rise and all febrile reactions lasting longer than the usual 3 day postoperative period as abnormal and every effort is made to explain these. It is, however, usually during the first 24 postoperative hours that the signs of postopera-

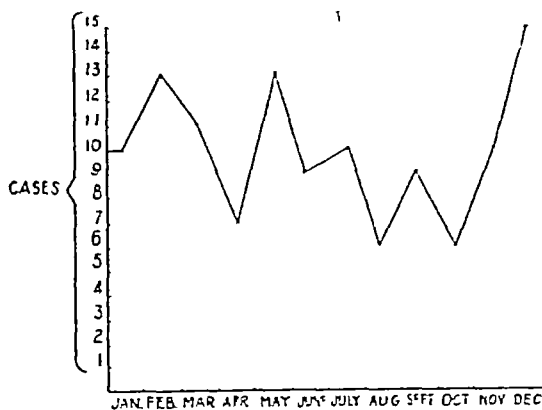


Chart 1 Incidence of pulmonary complications in various months. Series 1922-1931, 120 cases.

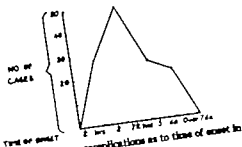
tive hypoventilation and collapse are present, and accordingly these must be looked for especially during this period. Symptoms calling attention to chest pathology appeared quite early in the postoperative course of the affected patients. Twenty-eight of the 120 cases had signs and symptoms referable to the chest during the first 24 hours after operation and 76 during the first 72 hours of the postoperative period. It is this prompt appearance of the complication that caused the earlier clinicians to attribute them entirely to the anesthesia inhaled (Chart 2).

In all cases in which it was deemed feasible, X-ray examination was made, and it was a constant practice to have a medical consultant see the cases. In this series, positive X-ray diagnosis was made in 35 cases. In the remaining instances, examination by X-ray was not made either because the patient was too desperately ill to be subjected to such an examination or the lesion was so clear cut and the patient's recovery so prompt and satisfactory that such examination was not considered necessary.

As a class, postoperative pulmonary complications run a very rapid course, ending either with a satisfactory recovery of the patient, or death. During the first 3 postoperative days, pulmonary complications had appeared in 38 of our series and of these 19 succumbed within that period. Eighty-five of the total series were terminated within the first 7 postoperative days, with recovery in 60 and death in 25 cases. In only 35 cases the pulmonary complication lasted longer than 7 days (Chart 3).

Such a summary impresses upon one that pulmonary complications are very malignant as a group, striking early, and most deadly when chest signs appear early with rapid progression.

Chart 2. Pulmonary complications as to time of onset in postoperative period.



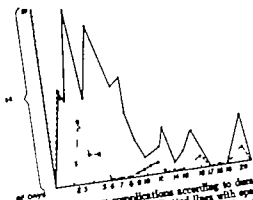
PROPHYLAXIS

It will be through a more careful pre-operative, operative and postoperative supervision that a reduction in the number of these complications will be obtained. Unfortunately one is handicapped in regulating the pre-operative care of the respiratory tract on a general surgical service where many patients must be operated upon as acute surgical emergencies in spite of the presence of upper respiratory infections. Of these 120 cases here mentioned, 55 were admitted to the hospital as acute emergencies for immediate operation. In this group greater care in the selection of a suitable anesthetic and more rigid supervision of the chest condition during the postoperative period will no doubt accomplish much.

In those cases in which the patient enters the hospital for an operation of election or for chronic disease one must accept the responsibility of rendering the respiratory passages as free from foci of infection as possible. Dental and tonsillar sepsis should, in all cases possible, be corrected before more major surgery is undertaken. The presence of a rhinopharyngitis or bronchitis is a definite indication to postpone all but emergency surgery. Every effort should be made to bring the patient to the operating room as free from respiratory infection as possible. All too often impatience on the part of the surgeon, the patient, or his family, causes the operation to be undertaken too soon after an acute respiratory infection. At least a week should intervene between the last symptoms of the cold and the surgical operation.

It is frequently noted that patients entering the surgical wards for a few days' study before operation develop acute respiratory infections during the pre-operative period. Many factors contribute in the production of these infections, some of which can be controlled by better supervision. The patient on admission to the ward is relieved of the warm clothing to which he has been accustomed and, in their stead, frequently is given an open backed gown and a pair of light trousers.

Chart 3. Pulmonary complications according to duration in days shown in solid lines. Dotted lines with open circles represent fatal cases in respect to duration of complication.



After a hot bath he is assigned to a bed on which he may find sheets instead of heavy blankets between which he has been sleeping. The covering he finds on the bed may be short and somewhat scant and he may be placed beneath one of the windows that is opened each night to insure free ventilation of the ward. If he is a hardy person and does not catch cold, all is well, but some are less fortunate and develop colds which they may take with them to the operating room.

It is because of the frequent occurrence of just this order of events that it is important for the interne or better the assistant to make it an inflexible rule to visit each patient on the morning of operation, to ascertain the presence of any abnormality in the temperature, pulse, or respiration, or any recently acquired cold. Because of such findings frequently the operation is cancelled on patients who are found to have a temperature of 99 to 99.2 degrees on the morning of their operation without other signs or symptoms. Only by such care can dangerous complications be avoided.

In the selection of the best anesthetic agent for a given patient, many factors are concerned. As previously noted, respiratory infections occur almost as frequently following spinal and local anesthesia as they do following inhalation anesthesia. However, considering it purely from the respiratory standpoint, the short ethenic type of individual with a thick, short neck, and a plethoric subcutaneous countenance neither takes nor tolerates well an ether anesthetic. If in such a patient the surgical procedure to be undertaken can be done as satisfactorily under local or spinal anesthesia, these would be the agents of choice.

Every patient who presents himself must be individualized and the anæsthetic selected that is safest from every standpoint.

The transportation of the patient to and from the operating room is not without its hazards. Hospital halls, particularly in the older institutions, are notoriously equipped with drafts and every effort should be made to make the trip to and from the operating room as quickly as possible with the patient warmly wrapped. In placing the patient on an operating table it is well to remember that the only coverings between the patient and the steel of the table are a thin rubber mat and a brief sheet, scant protection for one who will remain fixed in a given position for an hour or longer, probably perspiring profusely during that period.

The value of carbon dioxide as a respiratory stimulant and in the prevention of postoperative hypoventilation and collapse is now well recognized and accepted. Whether the carbon dioxide be given in concentrations of 10 per cent or 30 per cent, and whether it be given in short bursts or over longer periods seem to be but matters of personal preference. The fact remains well established that by its use the frequency of atelectasis is greatly reduced and the subsequent development of infectious pulmonary complications becomes more infrequent.

In this series on our service during the past 3 years, 10 per cent carbon dioxide in oxygen has been given to each patient receiving ether anæsthesia at the end of the operative procedure. It has not been a routine practice in patients receiving nitrous oxide gas anæsthesia or nitrous oxide gas with small quantities of ether vapor, unless the anæsthetic be a difficult one or its administration requested by the operating surgeon. Carbon dioxide in small quantities has not been administered to patients on their return to the surgical wards after operation as is done in some institutions to increase the depth of respiration and hasten the recovery of the patient from the anæsthetic. Pharyngeal suction aspiration is practiced during the anæsthesia when indicated.

On his return to the surgical ward the patient is placed in a flat position until awake if the anæsthetic has been general and then all patients who have had abdominal operations are placed in a semi Fowler position, unless there is some definite contra-indication. Patients receiving spinal anæsthesia are placed in bed with the foot elevated 6 inches, for a period of 6 hours, then flat in bed for 18 hours, and into the semi Fowler position at the end of 24 hours. By following this routine headaches after spinal anæsthesia have been re-

duced to a minimum, but in those cases in which it is felt important to have the patient in the semi Fowler position earlier, the 18 hour period is reduced and the head is elevated after 9 or 12 hours.

All patients are instructed to take breathing exercises as soon as they are conscious following anæsthesia. These consist in taking at least 10 deep breaths each waking hour. They are told to inspire slowly and gently and then to expire rapidly. The slow inspiration causes less pain and consequent inhibition, while the more forcible expiration not only is not painful but tends to force the mucus up into the position where the cough reflex will dispose of it. The great importance of these exercises is explained to the patient and he is advised to fill his lungs to the greatest possible extent even though with hyperventilation he does experience a little discomfort or pain in the operative site. Often fear of rupturing the incision makes the patient hesitant about taking breaths of the desired depth, and it is explained to him that there are no grounds for his fear. Nurses in charge constantly supervise these exercises and the patient is not permitted to forget their importance.

In all abdominal cases in which it is possible the patients are turned from side to side at intervals of 2 hours. However, they are turned by the nurses on the wards and not permitted to do so themselves until the dangers of resulting complications involved in doing so themselves are past. We feel that this procedure alone is very important in preventing dependent congestion and atelectasis.

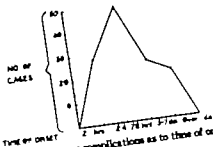
Very tight upper abdominal dressings are to be avoided, and unless there is a definite indication, upper abdominal binders are not used. Sise has shown that the use of a tight upper abdominal binder alone can reduce the vital capacity of a normal chest 30 per cent.

Each patient after operation is provided with a shoulder blanket which is carried across the back of the shoulders and neck and over the anterior portions of the chest, covering those portions of the body most exposed to drafts and chilling when one is in a semi Fowler position. Patients continue to wear these blankets while in bed and during the first few days that they are permitted up in a wheel chair.

All these listed procedures are routine in the prevention of the postoperative pulmonary complication. The great importance of rigidly observing this routine in each patient after operation must be constantly emphasized by those supervising the care of patients.

SURGERY GYNECOLOGY AND OBSTETRICS

Chart 2. Pulmonary complications as to time of onset in postoperative period.

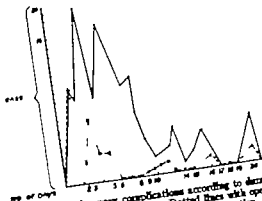


PROPHYLAXIS

It will be through a more careful pre-operative, operative, and postoperative supervision that a reduction in the number of these complications will be obtained. Unfortunately one is handicapped in regulating the pre-operative care of the respiratory tract on a general surgical service where many patients must be operated upon as acute surgical emergencies in spite of the presence of upper respiratory infections. Of these 130 cases here mentioned, 55 were admitted to the hospital as acute emergencies for immediate operation. In this group greater care in the selection of a suitable anesthetic and more rigid supervision of the chest condition during the postoperative period will no doubt accomplish much.

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In spite of all effort, pulmonary complications still do and will occur though we hope the percentage will become smaller. When they do appear they are treated promptly and the advice of an experienced internist is obtained to assist. Symptomatic measures, including a high fluid intake, plenty of fresh air and rest, are observed routinely. A crop tent with inhalations and small quantities of codeine usually cure for the bronchitis frequently seen. Pneumonia when present is treated by the medical consultant. Those cases in which the question of a lobular atelectasis or a pneumonia arises are rolled from side to side at frequent intervals, as described by Sante. An oxygen tent is used, if cyanosis is present. Bronchoscopy may be of value in definite cases of atelectasis as shown by Jackson, Lee, and Tucker. The administration of carbon dioxide has been advised in the treatment of postoperative atelectasis and, on theoretical grounds, it would seem to be the treatment of choice. Atelectasis, if unaccompanied by infection, practically always recovers spontaneously within a short period but the great danger lies in the possibility of these atelectatic areas becoming infected with the development of a pneumonia with its high mortality.

SUMMARY AND CONCLUSIONS

1. An analysis of 7,326 general surgical procedures is presented in which 120 postoperative pulmonary complications occurred with 39 fatalities.
2. The morbidity of postoperative pulmonary complications in this series was 1.68 per cent, with a general mortality of 0.54 per cent from this complication.
3. In this series 32.5 per cent of the patients affected with pulmonary complications died.
4. Postoperative pulmonary complications were entirely responsible for 8.5 per cent of the total operative mortality in this series of 7,326 operations and partially responsible for 15.5 per cent of the total operative mortality.
5. Upper respiratory infections at the time of operation are a very real contributing cause in the development of postoperative pulmonary complications and only acute surgical emergencies should come to operation in the presence of such.
6. Pulmonary complications occur equally following the administration of all anesthetic agents but the length of the anesthetic is a definite contributing factor.
7. Operations on the stomach, duodenum, and jejunum are most frequently followed by these complications, with those on the gall bladder and appendix next in order.

8. Blood pressure changes and the use of morphine after operation have had no effect on the incidence of these complications in our series.

9. Pulmonary complications occur with the greatest frequency between the months of November and March.

10. Seventy per cent of our cases were male patients.

11. Pulmonary complications as a class appear early and run a rapidly fatal course to their termination, being fatal in approximately 30 per cent of the affected cases.

12. Carbon dioxide inhalations are of great value in preventing postoperative atelectasis and its sequelae.

13. All patients after operation should be given supervised breathing exercises and be turned at 2 hour intervals if at all possible.

14. Constricting dressings and upper abdominal binders are to be avoided.

15. Pulmonary complications, when they occur should be treated promptly with both symptomatic and specific measures for their relief.

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THE SURGICAL MENOPAUSE AFTER HYSTERECTOMY WITH AND WITHOUT OVARIAN CONSERVATION

J. WALTON SESSUMS, M.D. AND DOUGLAS P. MURPHY, M.D. F.A.C.S. PHILADELPHIA, PENNSYLVANIA
From the Gynecologic Hospital, Institute of Gynecologic Research, and the Hospital of the University of Pennsylvania

IN a recent study of the surgical menopause occurring after hysterectomy with the retention of one or both ovaries, 43 per cent of 91 patients, operated upon before 36 years of age experienced hot flashes before the age of forty.¹ This percentage was approximately eight times that occurring in a group of women of corresponding ages not operated upon.

The incidence of flashes was found to be lower in the patients who menstruated subsequent to operation than in those who did not menstruate and also less frequent among women retaining both ovaries than in those from whom one had been removed. From these observations, it was concluded that, when attempting to prevent the development of the surgical menopause, ovarian and endometrial conservation serve the best interest of the patient subjected to a hysterectomy during the childbearing period.

On the other hand, certain observers advocate extirpation of both ovaries when the uterus is to be removed before the climacteric. They claim that, though more severe, the subsequent surgical menopause is shorter than this short but severe condition is preferable to a less acute one which will be more prolonged.

The authors concluded that conservation is the policy of choice because, following its pursuit, fewer patients developed symptoms of the surgical menopause. This feature was not mentioned by the observers already alluded to who tacitly assumed that a surgical menopause would develop; they were concerned primarily with its duration.

Since these two points of view in determining the extent of operation were diametrically opposed, largely if not entirely because they were based on different observations and reasons, a second study was undertaken.

These observations were made upon patients operated upon in the John G. Clark Clinic of the Hospital of the University of Pennsylvania. Ninety-one women, subjected to a hysterectomy

with the conservation of one or both ovaries² and 51 subjected to a hysterectomy and a bilateral oophorectomy were studied. A subtotal hysterectomy was the operation of choice in both groups, on all but 6 patients; a total hysterectomy was performed upon the latter. All were operated upon before the thirty-sixth year of life. They were followed either by mail or were interrogated in the Hospital Follow Up Clinic and in many instances information was secured from both sources. The study concerned patients operated upon between the years of 1916 and 1930. Data were collected concerning the incidence, the onset, and the severity of the flashes, and the number of months or years that they were experienced. It is our belief that their presence is the best index that the menopause has set in and, on account of the definiteness of this symptom, and the vagueness of the other menopausal symptoms, the flash was the only symptom investigated.

Incidence of flashes. Of 91 patients subjected to hysterectomy with conservation of one or both ovaries, 40 (43.9 per cent) developed hot flashes before 40 years of age, whereas, of 51 patients who were subjected to hysterectomy with bilateral oophorectomy 43 (84.3 per cent) developed hot flashes before 40 (Table I). From these observations, it is evident that the flash was much more common after bilateral than after unilateral oophorectomy.

Onset of flashes. Of 40 patients developing flashes after hysterectomy with ovarian tissue conservation, 14 (35 per cent) developed them during the succeeding 3 months, whereas, of 43 patients experiencing flashes after hysterectomy with removal of both ovaries, 35 (81.3 per cent) developed them during the same period of time (Fig. 1). The flashes appeared sooner, therefore after bilateral than after unilateral oophorectomy.

Severity of flashes. Of the 40 patients who experienced flashes after hysterectomy with ovarian conservation, 15 (37.5 per cent) described the flashes as being severe, while the remaining ones used the terms moderate or mild (Table II). Of the 43 patients who experienced flashes after

¹ By joint writers, the latter flash and flash are used synonymously. It has been suggested that the term flash be restricted to the sensation which includes an associated vascular stimulation. Since in this investigation, no inquiry was made regarding vascular stimuli, the term flash is used throughout.

² Sessums, J. V. and Murphy, D. P. Hysterectomy and the (a) clinical course of menopause and report of 91 cases. Surg. Gynec. & Obst., 1931, 52, 266.

The severity of these patients by and the time of the present report, but the latter did not indicate the date presented here, flashes with severity and duration of the surgical menopause.

TABLE I—INCIDENCE OF FLUSHES IN PATIENTS UNDER 40 YEARS

	Number of patients	Per cent
Hysterectomy with conservation of one or both ovaries	91	43.9
Hysterectomy with bilateral oophorectomy	52	80.7

Percentages of patients operated upon before 36 years of age and exhibiting hot flushes before 40 years of age, as influenced by the amount of ovarian tissue removed. Note that, in the group where both ovaries were removed, approximately twice as many women experienced hot flushes as did those in the group where one or both ovaries were retained.

TABLE II—SEVERITY OF FLUSHES

	Number of patients	Flushes severe
Hysterectomy with conservation of one or both ovaries	40	15
Hysterectomy with bilateral oophorectomy	41	30

Severity of flushes following hysterectomy with and without ovarian conservation. Note that just twice as many women, subjected to hysterectomy with bilateral oophorectomy, reported their flushes as severe, as did the patients, subjected to hysterectomy with ovarian tissue conservation.

TABLE III—PERIOD OF TIME DURING WHICH FLUSHES WERE EXPERIENCED

	Number of patients	Flushes stopped per cent	Average duration in months
Hysterectomy with conservation of one or both ovaries	40	35	16.2
Hysterectomy with bilateral oophorectomy	41	12	7.2

Percentages of patients subjected to hysterectomy with and without ovarian conservation, who reported that their hot flushes had stopped, and the length of time during which they had experienced these symptoms. Note the very small percentages of patients who reported cessation of flushes, and also the fact that the period of time that the flushes existed was smaller after bilateral oophorectomy than when one or both ovaries were conserved.

hysterectomy with bilateral oophorectomy, 30 (73.1 per cent) described the flushes as severe, and the 11 remaining as moderate or mild (Table II). From this comparison it is seen that, in the group subjected to hysterectomy with bilateral oophorectomy, twice as many women described their flushes as severe, as did those in the group subjected to hysterectomy with ovarian tissue conservation.

Duration of surgical menopause. Of 40 patients subjected to hysterectomy with ovarian conservation, only 14 (35 per cent) reported their flushes as having ceased (Table III). The duration of the surgical menopause in this group averaged 16.2 months. Of 41 patients subjected

ONSET OF FLUSHES

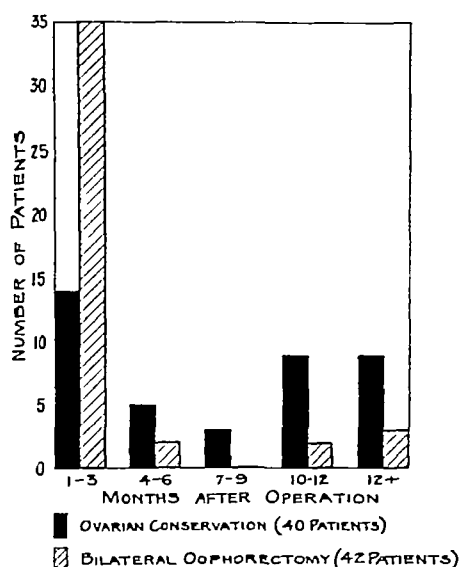


Fig. 1 The interval of time between operation and the onset of flushes developing after hysterectomy with and without ovarian tissue conservation. The base line represents the length of time, in periods of 3 months, between operation and the development of flushes, the vertical line represents the number of patients studied. Note the large number of patients developing flushes within the first 3 months following operation, especially in the group subjected to hysterectomy and bilateral oophorectomy.

to hysterectomy and bilateral oophorectomy, only 5 (12 per cent) reported their flushes as being completed (Table III). The duration in this group averaged 7.2 months. The length of the surgical menopause after bilateral oophorectomy was shorter therefore than after unilateral oophorectomy in the small number of patients where data were available concerning the completed condition. In evaluating this observation, two facts must be borne in mind: first, the small number of patients operated upon in both groups, and, second, the very small percentage of patients (averaging less than 25 per cent) concerning whom information was available. This latter observation is of interest in view of the length of the period of time covered by the study, which was 14 years.

In an investigation of the duration of the surgical menopause of the patients who were experiencing flushes when last observed, it was noted that the lengths of their periods of observation were about equal in the two groups (Fig. 2).

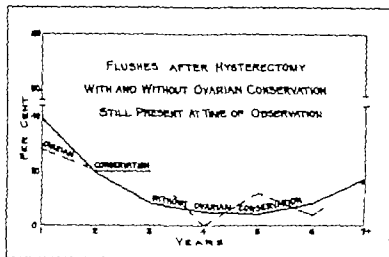


Fig. Polygon curves showing the lengths of the periods of observation of patients who developed flashes after hysterectomy and who still had them at the time of last observation. The above curve is based upon observations on 3 weeks on whom ovarian tissue conservation was practiced, and upon 36 women on whom ovarian tissue conservation was not practiced. The base line represents the intervals of time in years between the first flash and the time of last observation. The vertical line represents the percentages of patients in the two operative groups, who were still flashing. Note that, regardless of the length of time between the first flash and the time of the last observation, the percentage of patients in each group was approximately the same.

DEDUCTIONS

In view of the above facts, and especially because of the small number of patients from whom information could be secured concerning the duration of the surgical menopause, it is believed that as yet little weight should be placed upon it, in determining the amount of ovarian tissue to be sacrificed when a hysterectomy is to be performed during the childbearing period.

This report confirms the findings of others, namely that the incidence of a severe surgical menopause, is much more common when bilateral oophorectomy is performed than when one or both ovaries is conserved. Since the surgical menopause is more likely to occur the more ovarian tissue is removed, since the flashes are more severe under the same conditions, and since the meager information on the duration of the surgical menopause points to the fact that the duration is so slightly different in the two operative groups, it is believed that the advantages of conservative ovarian surgery outweigh those of following a more radical policy. Furthermore, it is believed to be more important to aim at preventing the onset of the surgical menopause than to assume it will occur and then attempt to reduce its length.

SUMMARY AND CONCLUSIONS

1. Ninety-one women subjected to hysterectomy with retention of one or both ovaries, and 36 women, subjected to hysterectomy and bilateral oophorectomy both groups before the age of 30 years, have been interrogated with reference to the incidence, onset, duration and severity of the surgical menopause, as indicated by its most important symptom, the hot flash.

2. The surgical menopause occurred in more patients, it took place sooner, and was more severe after hysterectomy with associated bilateral oophorectomy than when one or both ovaries were conserved.

3. The surgical menopause after hysterectomy with and without associated bilateral oophorectomy still persisted in three-fourths of our patients at the time of last observation. In the remaining one-fourth, it had been completed. Its duration was shorter after associated bilateral oophorectomy than after hysterectomy with ovarian conservation.

4. From this study, and a previous one it is concluded that, when hysterectomy is to be performed during the childbearing period, the best interest of the patient is guarded by conservative treatment of ovarian tissue.

STUDIES ON PERIPHERAL VASCULAR PHENOMENA

I A NEW DEVICE FOR THE STUDY OF PERIPHERAL VASCULAR PHENOMENA IN HEALTH AND DISEASE

CARL A JOHNSON, M S, M D, CHICAGO

From the Departments of Medicine and Physiology of Northwestern University and St. Luke's Hospital Chicago

MANY plethysmographs have been described since the time of Jan Swammerdam (1637-1680) and he is credited with having devised the first plethysmograph which he used in the study of the physiology of muscular contraction. A diagram of this plethysmograph is shown in his works edited by Boerhaave (1737)¹

In a previous communication² an extremely sensitive, very simple and readily adaptable plethysmograph was described which, for clinical studies, possesses many advantages over other instruments used for the study of peripheral vascular phenomena. Since that time, many refinements have been added to this device which, it is felt, require further description with indications of its possible applications of the apparatus to physiology and clinical medicine.

THE INSTRUMENT

The plethysmograph previously described (Fig 1, A) consisted of a 1-inch test tube cut off to about a 3 inch length. A 1 cubic centimeter pipette graduated to 0.01 cubic centimeter was fused to the closed end of a test tube. A glass stop cock was fused to the side of the test tube and the open end of the test tube was covered with dental rubber dam with a hole sufficiently large to admit any finger snugly (Fig 1, A).

When prepared for use, a drop of colored alcohol³ is allowed to run to the center of the pipette, the glass stop cock is left open, and the open end of the pipette is covered with the finger. The subject now puts one finger through the rubber dam into the test tube and assumes a comfortable position with the

hand and forearm resting on the table. The pipette is kept horizontal and the glass stop cock is closed.

The droplet oscillates with each heart beat. In the normal subject the oscillation varies from 0.01 to about 0.05 cubic centimeter (2 millimeters to 5 or 6 millimeters of linear deflection) depending upon various factors which will be mentioned later. In one case of aortic regurgitation the deflection varied in the third finger of the right hand from 0.04 cubic centimeter to 0.13 cubic centimeter depending upon the degree of vascular dilatation (9 millimeters to 27 millimeters linear deflection).

It is possible to construct these instruments with far greater sensitivity by using pipettes of smaller bores but for practical use upon patients and dogs they are unsatisfactory. The greater the sensitivity, the greater the difficulty in maintaining adjustments. For ordinary use the instrument described serves very well.

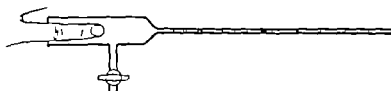
The plethysmographs as now constructed are similar to the first (Fig 1, A), except that the stop cock is fused to the proximal end of the pipette and the pipette is connected to the test tube by means of a rubber tube. Chambers for other parts such as the toes, leg, and arm can be substituted for the finger chamber and records from these parts made (Fig 1, B, C, D).

Photographic registration is accomplished by means of a special camera as shown in Figure 1, B, C, D. The pipette is a sufficient distance from the sensitive paper so that the graduation markings appear as horizontal white lines and the finger volume changes are registered by the change of position of the white band (Figs 2, 3, 4, 5, 6). From the photographic records it is possible to estimate a 0.002 cubic centimeter deflection. Further, with this device, it is possible to obtain graphic records on the five fingers of one hand within

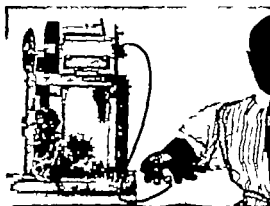
¹Jan Swammerdam (1637-1680) *Biblia Naturae*. Edited by Boerhaave (1737) Vol. iii, Table 49 Figures 7 and 8.

²Johnson, Carl A. *J. Lab. & Clin. Med.*, 1931 xvii, 59.

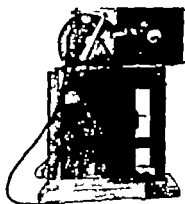
³A drop of alcohol was used for recording instead of water because of its more desirable physical properties. It has a low specific gravity, low viscosity and low surface tension and these decrease its resistance to movement. Furthermore the drop does not tend to be impeded in its movement by the film of grease which tends to collect on the walls of the pipette.



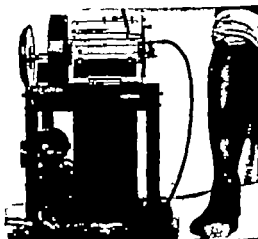
A



B



C



D

Fig. The apparatus (Photograph A) shows the finger plethysmograph as originally designed. Photographs B, C, and D illustrate the device for photographic

5 minutes. (Of course this does not include the time required to develop the photographic record.)

ILLUSTRATIONS

The accompanying illustrations demonstrate the utility of the instrument. Further

registration of the movements of the droplet of fluid in calibrated pipette. The droplet is visible in the pipette in B and D.

studies upon peripheral vascular phenomena have been made by Drs. Scupham and Johnson as reported elsewhere in this issue.

Figure 3 shows the normal response from the first four fingers of a patient in whom a diagnosis was made of chronic myocarditis,

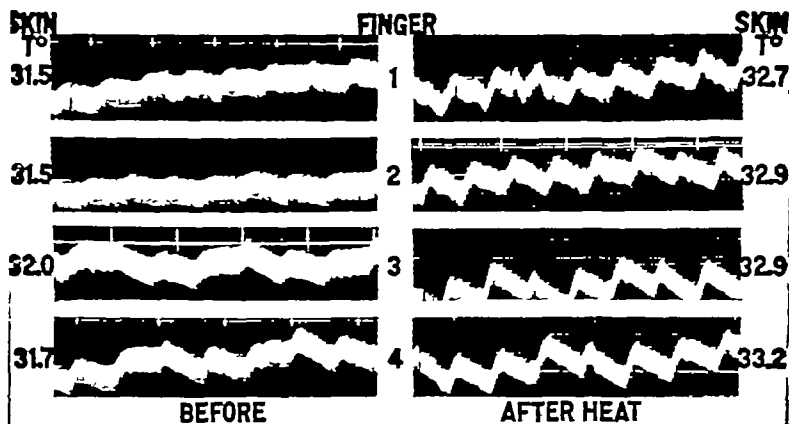


Fig 2 The normal response in the volume changes of the fingers of the right hand before and after local application of heat. It is noted that local heat induces a marked increase of the pulse volume changes. Occasional extrasystoles are recorded.

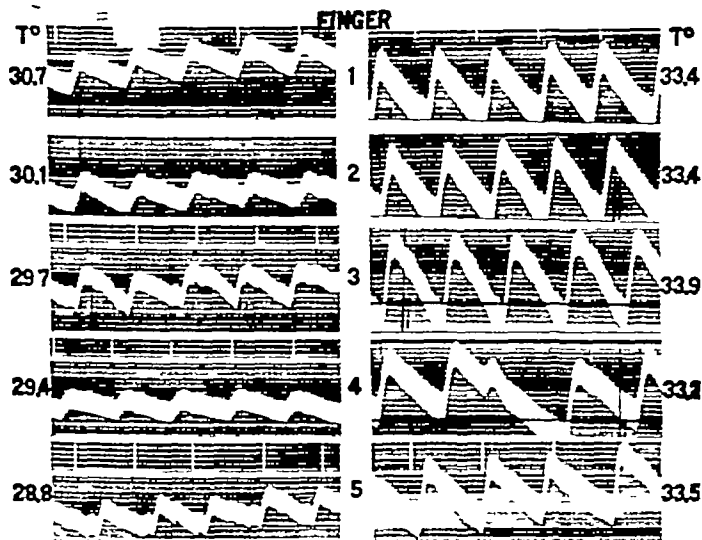


Fig 3 This record here is similar to that in Figure 2 except that this subject had an aortic regurgitation. The left column is the control and the right column shows the volume changes in the fingers after heat. The blood pressure in the patient was 140/40-0. Note that an extrasystole is recorded in the plethysmogram of the fourth finger.

before and after placing the hand in hot water for 5 minutes. There is an increase of about 400 per cent in the deflection.

Figure 3 shows the striking result from a similar experiment upon a patient with aortic regurgitation. It is noted that the deflection in the control record is above normal, i.e., about four times as great. Placing the hand

in hot water also increased the deflection in this case from 300 to 400 per cent. (In finger four an extrasystole is recorded.)

The results of an experiment upon posture and exercise are shown in Figure 4. This is the same case as shown in Figure 3 and the markedly decreased deflection after exercise is possibly explained by the fact that this

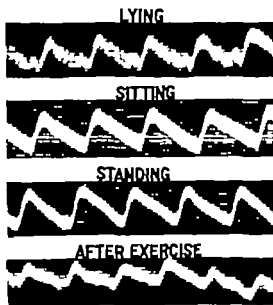


Fig. 4. The effect of posture and exercise on the pulse volume changes of the right index finger in a case of aortic regurgitation with cardiac decompensation. Blood pressure was 40/40-0.

patient is on the verge of cardiac decompensation (the aortic regurgitation is complicated by a bundle branch block).

Figure 5 shows the effect of heat on finger volume changes of one finger of each of four patients before and after the immersion of the hand in hot water. The most striking change occurred in the patient with severe hypertension and arteriosclerosis and serves to illustrate that peripheral vasodilatation is still possible in spite of an obvious arteriosclerosis with marked hypertension. In such a case it is possible to differentiate between functional and pathological constriction of the blood vessels.

Figure 6 is a record of the volume changes in the first four fingers of the right hand of a patient with thrombo-angitis obliterans before and after immersion in hot water. From the preceding discussion in the normal one should expect increased deflection following heat which did not occur. (In this case there has been loss of tissue in the first two fingers of the right hand.) The third finger shows a good pulsation. This further illustrates that

with this device one can differentiate between functional and organic constriction of the peripheral vessels. (Dr Scapham and Dr Johnson are making an extensive study of peripheral vascular diseases and this case represents one of the series.)

Figure 7 shows the changes of volume of the large toe in four subjects before and after immersion in hot water. The character of the impulse is different from that obtained from the fingers in that the return of the deflection to the base line is more rapid for the toe. The cause of this difference is not known. Possibly gravity and the greater distance from the heart are factors. The illustration is self explanatory except that the hypertensive patient had a good response in the fingers but none in the large toe.

DISCUSSION

It was obvious from the start of these experiments that the periodic volume changes or oscillations are associated with the pulse, but occasionally in some subjects there are superimposed slower periodic oscillations which are associated with respiration. It has not been determined whether these later changes are due to periodic vasomotor changes, changes in cardiac output or artifacts from body movement. Furthermore, in nervous patients the effect of tremor is recorded and these movements must be taken into consideration in the interpretation of results. Figure 2 shows all of these types of changes and was chosen to illustrate that accurate measurements of finger volume changes of cardiac origin can be made in spite of these second and third types of oscillations. This is important since it does not limit the use of the instrument to patients who are not nervous.

The instrument also may be used to measure the more lasting finger volume changes which occur from an increased or decreased vasomotor tone. This was illustrated in a previous communication on "The Effect of Amyl Nitrite upon Finger Volume."¹ It will be recalled from this paper that contrary to the accepted opinion amyl nitrite may cause a primary decreased finger volume in spite of a potential relaxation of the vessels. This is

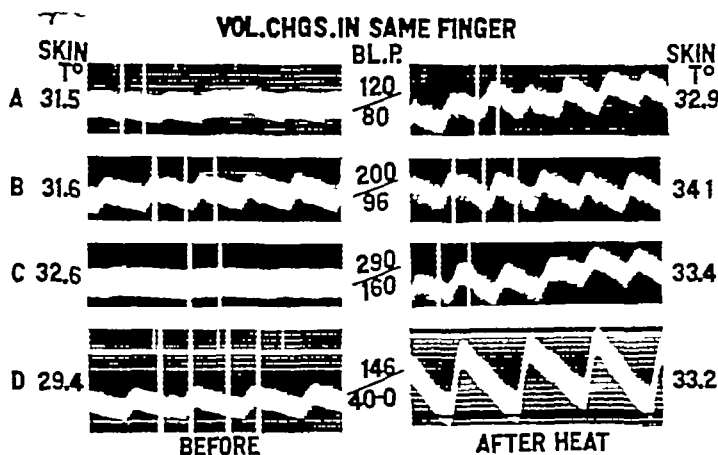


Fig 5 This figure merely illustrates the various types of plethysmograms one obtains from the finger in patients with various kinds of cardiovascular diseases. A Is a "normal" response of a finger to local heat in a patient with chronic myocarditis. B Shows a "normal" response to local heat in a patient with an aortic aneurism. The patient has an increased pulse pressure which is reflected in the control record. C Illustrates a striking response to local heat in a patient with a marked hypertension on an arteriosclerotic basis. This shows the marked degree of functional constriction of the smaller vessels in this patient as contrasted with the organic constriction in the patient with Buerger's disease illustrated in Figure 6. D Shows the increased volume change in the finger of a patient with aortic regurgitation and the marked degree of relaxation of the vessels which may be obtained after application of heat locally.

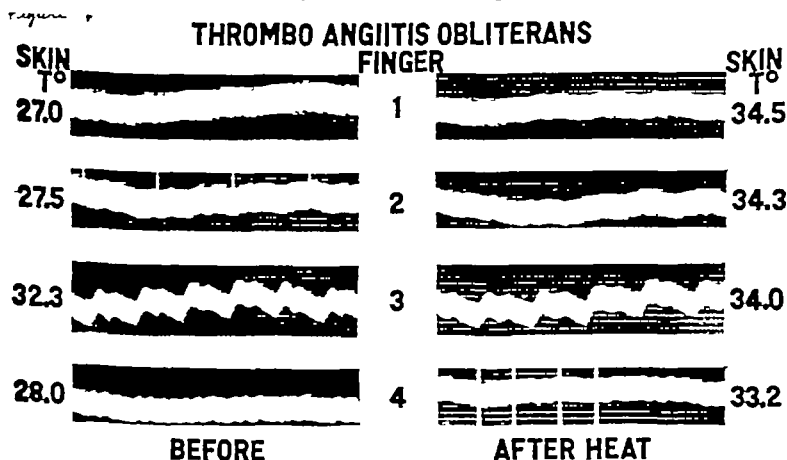


Fig 6 This figure shows records of the volume changes in the fingers of the right hand of a patient with thrombo angitis obliterans. The third finger apparently has a good circulation but the vessels manifest no vasoconstrictor tone, or the entire capacity of the vessels to dilate is being constantly utilized which is evidenced by the absence of an increase in pulse volume change from local heat. This illustrates the utility of the instrument in differentiating between different degrees of organic as well as functional constriction of the smaller blood vessels.

explained by the overwhelming splanchnic dilatation and drainage of the blood from the peripheral blood vessels.

The question of the accuracy of the instrument has arisen. As far as the deflection of cardiac origin is concerned, the plethysmo-

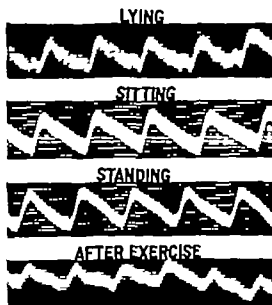


Fig. 4. The effect of posture and exercise on the pulse volume changes of the right index finger in a case of aortic regurgitation with cardiac decompensation. Blood pressure was 140/90-0.

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SUMMARY AND CONCLUSIONS

A new device has been presented for the study of peripheral vascular phenomena in health and disease and illustrations have been

shown to demonstrate its utility in physiology and in clinical medicine

Some tentative conclusions have been drawn

1 This device may be used to differentiate between functional and organic constriction of the peripheral blood vessels

2 This device is a more accurate index of vascular dilatation than skin temperatures

STUDIES ON PERIPHERAL VASCULAR PHENOMENA

II OBSERVATIONS ON PERIPHERAL CIRCULATORY CHANGES FOLLOWING UNILATERAL CERVICAL GANGLIONECTOMY AND RAMISECTOMY

CARL A. JOHNSON, M S, M D, GEORGE W. SCUPHAM, M D, AND N. C. GILBERT, M S, M D, CHICAGO
From the Departments of Medicine and Physiology Northwestern University and St. Luke's Hospital Chicago

SYMPATHECTOMY and sympathetic ganglionectomy have been done for several clinical conditions, with some conflicting results. In this paper we wish to consider only those conditions in which sympathectomy is done in an attempt to increase the blood supply to the whole or part of an extremity.

The literature on the sympathetic nervous system and its relation to the peripheral vascular bed is very extensive, but it may be found in the excellent monographs of Kuntz and Krogh. Unless otherwise indicated, references to the following literature may be found in these monographs. Also the functional activity of the capillaries and venules is reviewed in a monograph by Hooker.

On histological grounds alone it has been demonstrated by numerous authors that fibers from the sympathetic nervous system pass to the arterioles. There is evidence that sympathetic fibers also pass to the capillaries and veins.

Physiologically it has been shown in numerous ways that these fibers are chiefly vasoconstrictor in nature and exert a tonic influence over the peripheral vascular bed. There are also vasodilator fibers but these in most instances are not so readily demonstrable as are the vasoconstrictor fibers. It has also been shown that the capillaries may constrict independently of the arterioles and that this

constriction is due in part to vasoconstrictor impulses over the sympathetic.

In addition to this central control over the smaller vessels, there are peripheral mechanisms which aid in regulating the vascular bed purely in a local way. The evidence for this is by direct visual observation of the smaller vessels devoid of any central connections, and this evidence indicates that the vessels not only have an independent contractility but also are influenced by blood changes.

That these mechanisms of peripheral vascular control are effective is shown by the late effects of sympathectomy. According to Kuntz, from experiments upon normal animals, the blood vessels regain their pre-operative tone following sympathectomy in 10 days to 2 weeks. It is thought that capillaries regain their tone somewhat more rapidly than the arterioles.

Clinically, sympathectomy has been done for many conditions, but in this report we wish to limit ourselves to sympathectomy for the so called rheumatoid arthritis.

Brown, Rowntree and Adson, and Hench, Henderson, Rowntree and Adson report favorable results following sympathetic ganglionectomy and ramisectomy in rheumatoid arthritis. They indicate that in rheumatoid arthritis the extremities are cold to the touch, and also that there are pallor, areas of cyanosis, puffiness of the tissues, and the extremities are

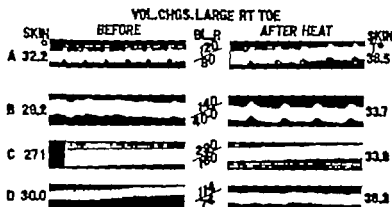


Fig. 7 This figure shows the various types of response in the large toe. *A* is the plethysmogram of normal individual showing that the pulse volume changes in the toe can be demonstrated readily. The response to local heat is not so marked as in the finger. *B* is from a case of aortic regurgitation. *C* Shows the absence of a pulse wave in the toe from a case of severe arteriosclerosis with hypertension. The reasons for this result are discussed in the text. *D* is from a case of thrombo-angitis obliterans which shows slight response to heat.

graph can be taken off the finger and reapplied numerous times and the same deflection will be obtained. In a finger with a volume of 15 cubic centimeters and a deflection of .015 cubic centimeter it is calculated that using volumes of 17 cubic centimeters or 13 cubic centimeters of finger will still give values within the range of experimental accuracy i.e. .005 cubic centimeter. This is important not only from the point of view of accuracy in duplicating results, but also demonstrates the ease of manipulation. In other words it does not require extraordinary technical skill to obtain consistent results with this instrument.

Another important consideration is the cost of the instrument. The essential portion i.e. the plethysmograph itself can be made for two dollars to two dollars and a half which is sufficient for making qualitative observations. It can be carried in the pocket. The camera can be made as elaborately as desired but the one in use which was found adequate would cost about three hundred dollars to duplicate.

The interpretation of the results is open to some question but it is felt that the same factors which maintain blood pressure in addition to the resistance of the soft tissues of the part in question are the important

factors in determining the extent of the excursion which is associated with the pulse. It will be remembered that the important factors which serve to maintain blood pressure are the force and rate of the heart, the volume and viscosity of the blood, the elasticity of the blood vessels, and the peripheral resistance.

For most experiments, all the factors remain fairly constant except the peripheral resistance. Illustrations of changing the peripheral resistance in the finger and toe by immersion in hot water have been shown and it is felt that this is an index of the degree of vascular dilatation. Furthermore, where there is pathological constriction of the vessels such as in thrombo-angitis obliterans, such relaxation is not possible. From this and other data it is concluded that with this instrument, it is possible to differentiate between functional and pathological constriction of the blood vessels. In other words, the deflection obtained is dependent upon the ability of the vessels to dilate with each heart beat and in this sense is a measure of vascular dilatation in the part.

There remains little else to be said except that it is felt that this small amount of investigative work with this device illustrates

and points out the utility of the instrument for the study of peripheral vascular phenomena in health and disease

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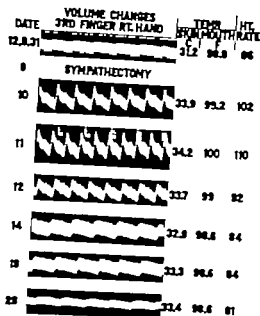


Fig. 1. This figure illustrates the volume changes of the third finger of the right hand before and after removal of the right superior cervical and first and second thoracic sympathetic ganglia. It is to be noted that the pulse volume changes of the finger return to the control level in days.

usually moist. They feel that these changes indicate constriction of the arterioles, capillaries, and possibly the venules. On the basis of previous studies on sympathectomy they had concluded from skin temperature studies and calorimetric studies that there is a lasting increased blood flow to the part following sympathetic ganglionectomy and ramisection.

With this introduction we wish to offer objective evidence of the results of a unilateral sympathectomy (removal of right stellate and first and second thoracic ganglia) of the upper extremity in one patient with rheumatoid arthritis.

B. C., a white female, aged 2 years, was first admitted to St. Luke's Hospital on August 28, 1929, and has been under constant observation ever since. A diagnosis of rheumatoid arthritis was made at this time.

The early manifestations of her disease started at the age of 12 to 13, but subside and were not severe

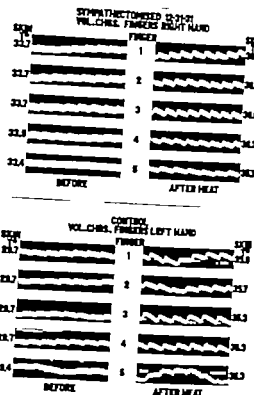


Fig. 2. This figure shows the effect of local heat (43 degrees for 30 minutes) on the pulse volume changes of the fingers of the right hand 22 days after sympathectomy as compared with the effect of local heat upon the volume changes of the fingers of the left or control hand. It is to be noted that a similar response is obtained in the fingers of both hands which shows that in this patient after 22 days, sympathectomy did not modify the reaction of the blood vessels to local heat.

until she reached the age of 18. The process has progressed until at the present time all of her joints except those of her spinal column are affected and deformed. She has the characteristic spindle-shaped joints of the fingers.

From time to time various types of medication were instituted in attempts to stop the progress of the disease and to alleviate the pain. Among these were foreign protein therapy, sulphur injections, an extensive course of vaccine therapy, a unilateral cervical ganglionectomy and ramisection of the upper extremities, and finally ankylosis of the wrist joints.

Sympathectomy of the right arm (removed right stellate and first and second thoracic ganglia) was done by Drs. Huddell and Harold L. Meyers on December 9, 1931. Control studies on skin temperature and circulatory changes were made at various intervals before and after operation.

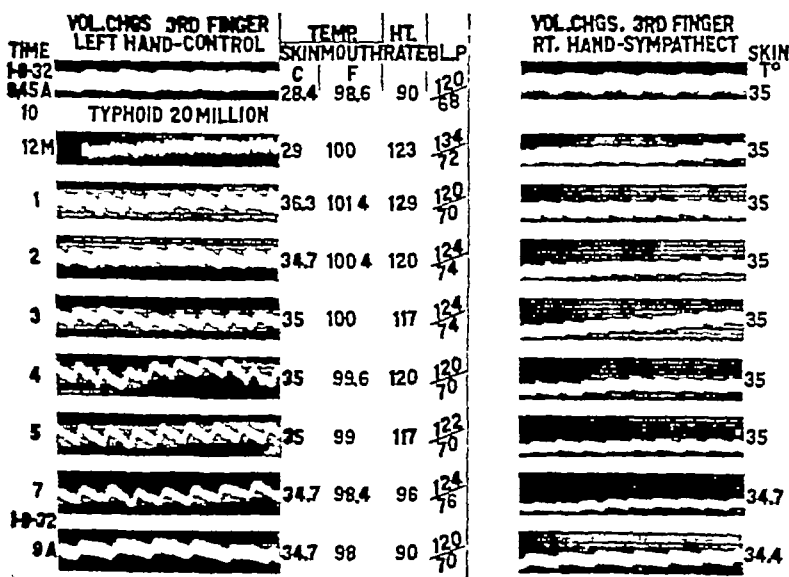


Fig 3 This figure shows the effect of fever as induced by foreign protein upon the volume changes of the third finger of both hands 1 month after sympathectomy. It is noted that a striking change is obtained in the third finger of the control hand but virtually no change in the volume changes of the third finger of the sympathectomized hand. It is also to be noted that in the control hand skin temperature and heart rate roughly parallel the volume changes of the finger. Very little change was observed in the sympathectomized hand. This indicates that vasodilation of artificially produced fever is of central origin.

The circulatory observations were made by means of a special plethysmograph previously described by Johnson in this issue. By means of this device we were able to make quantitative studies on the circulation in the fingers and note the changes which took place. Measurements of skin temperature were made by the ordinary thermocouple.

The results of the observations will be demonstrated graphically and we shall limit our discussion as much as possible to conclusions from objective experiments.

Figure 1 illustrates the marked increase in pulse volume following sympathectomy and its gradual return to the control level in 21 days. (It will be remembered that in the experimental animal the return of circulation to the control level is in 10 to 14 days (Kuntz), we attribute the variance (21 days) to the more sensitive method we have used.) The skin temperature of the sympathectomized side also increased and has remained increased for 5 months. It is noted from this figure that peripheral pulse volume changes do not parallel the skin temperature changes.

Figure 2 illustrates the effect of local heat to the upper extremities 22 days after sympathectomy. Merely placing the hands in hot water for 10 minutes at 45 degrees C was sufficient to increase the peripheral pulse volume of the fingers, and this was interpreted to mean vasodilatation. This record illustrates that relaxation of the smaller vessels is possible in the absence of central nervous connections (we are assuming that the ganglionectomy and ramisectomy destroys most if not all the vasoconstrictor fibers to the blood vessels of the right arm).

Figure 3 shows the effect of artificial fever as induced by foreign protein on the volume changes of the fingers 1 month after sympathectomy. In the control arm (left) the volume changes in the fingers, skin temperature, and the body temperature showed a uniform increase in each measurement. In the sympathectomized arm there was no significant change in the peripheral pulse volume or skin temperature. This record suggests that vasodilation from fever in the normal is

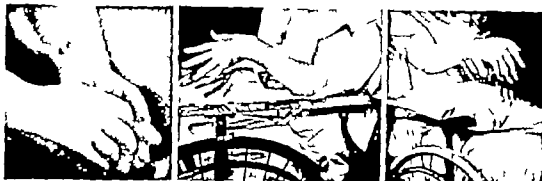


Fig. 4. This figure shows photographs of the fingers before and 4 months after sympathectomy of the right hand. The photograph at the left shows the fingers of the

right hand before and the right photograph the fingers 4 months after sympathectomy. Note the ulnar deviation of the fingers.

probably of central origin i.e. from a partial or total paralysis of the sympathetic constrictor tone. Further evidence that this is true is loss of sweating and increased skin temperature early in fever. It also suggests that the sympathetics normally exert a tonic influence over the smaller vessels which are inhibited in fever. The skin temperature of the sympathetomized hand was high and the superimposed fever was insufficient to induce any significant change in the skin temperature.

We were not able to note any appreciable color change of the sympathetomized extremity as reported by other authors. Other findings which we noted were loss of sweating in the operated upon side, a persistent Horner's syndrome, and indefinite changes in the character of the pain. It should be noted here that before operation both hands were moist and cool and since the operation the hand not operated upon has continued to remain moist and cool.

DISCUSSION

We believe that the volume change in the fingers with each heart beat is an index of blood flow to the part. We are fully aware of the criticism that more strictly speaking this method is an index of pulse volume and hence with a dilated vascular bed a greater blood flow could occur without an increase in pulse volume but we are of the opinion that this is not the case for the following reasons:

1. We were able to produce vasodilation of the sympathetomized vessels by local heat and the amount of vasodilation was about the

same as that produced by similar conditions in the control hand. If sympathectomy had produced a permanent maximum dilatation of the vessels, our results would not be so uniform on the control and sympathetomized sides. If there had been any dilatation at all we would expect some difference in response of the two hands following local heat.

2. The results are in keeping with the results of ganglionectomy and rambectomy on experimental animals. The pre-operative tone is established in 10 to 14 days (Kuntz). It would not be logical to assume that the control of vascular tone in animals (dog) is much different than that of the human.

3. The increased skin temperatures which are said by some authors to be an index of increased blood flow to the part following sympathectomy may be largely or totally due to a loss of part of the heat-regulating mechanism. It is well known that a great deal of the body heat is lost through sweating and an interference with this mechanism may be largely responsible for the increased local heat observed following sympathectomy. Further more we have experiments by this method to show that in fever in certain cases there is an increased temperature of the fingers but the circulation was markedly decreased as measured by the plethysmograph records, a marked fall in blood pressure and severe pain to the part. (This was in a case of Buerger's disease and will appear in a later report.)

4. This patient did not improve following sympathectomy alone. She was not given any

other treatment for 3 months in an attempt to evaluate this method of treatment for rheumatoid arthritis. As a matter of fact, the photographs before and after sympathectomy indicate that the sympathectomized side became worse. This is not good evidence of a permanent increased blood flow.

SUMMARY AND CONCLUSIONS

By means of a new method we have shown changes in circulation following sympathectomy which suggest the following conclusions:

1. There is an early relaxation of the vessels.

2. There is a progressive recovery of independent tone of these vessels so that the circulation has reached its pre-operative level in 21 days.

3. This indicates that normally the sympathetic exerts a tonic constrictor control over the smaller vessels.

4. Local relaxation of the blood vessels to local heat is subject to little or no central control.

5. Fever causes an early temporary inhibition of vasoconstrictor tone which accounts for the vasodilation observed. If there is a marked fall in blood pressure, the potential vasodilation will not manifest itself peripherally. The detailed explanation of this

may be anticipated from the results on the effect of amyl nitrite on the circulation (Johnson).

6. We believe the methods used in this study to be a more accurate index of circulatory change than skin temperature and supplies a simple method for further studies.

7. Our experiments in this case do not show a permanent increased peripheral circulation following ganglionectomy and ramisection and are in accord with results of animal experiments. We feel that the increased heat to the part following ganglionectomy and ramisection is due to the loss of sweating, evaporation, and possibly other minor unknown factors. The contrasting skin temperatures of the two arms in this case are probably due to the fact that one hand is practically always wet with perspiration, the other dry.

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CLINICAL SURGERY

TECHNIQUE OF OPERATION FOR CANCER OF THE FEMALE BREAST¹

END-RESULTS IN ONE HUNDRED AND TWENTY NINE CASES SEVEN YEARS AFTER OPERATION

JABEZ N. JACKSON, M.D., F.A.C.S., and JOHN H. OGILVIE, M.D. KANSAS CITY, MISSOURI

MY original operation for cancer of the female breast has been described many times previously and has become known to many surgeons as the "Jackson flap operation." As a matter of fact, the discovery of the flap was an accident incident to our main purpose, which was to bring the skin from below the pectoral fold up around the axillary vessels and thus to obliterate the axillary fossa. When this was done it was found that the skin from the front of the pectorals was no longer needed there, so it was slid over to cover the denuded area left when the breast was removed. While the obliteration of the axillary fossa was our main purpose, at the time the plastic flap seemed valuable. Later however in the course of our experience, we came upon a case in which the tumor was so far up in the outer quadrant of the breast as to involve the skin which would be used for the flap and we were forced to abandon its use. We, therefore, evolved another method which is applicable to all cases and which still preserves the main feature of the original operation, namely the obliteration of the axillary fossa. We now use this method most of the time.

In the meantime we had become familiar with what could be accomplished by extensive under-cutting of flaps and were able to close the much more extensive wound quite readily. This method I desire now to present with certain other details which either facilitate our work or more important, probably contribute much to end-results. We shall describe our present operation in detail.

TECHNIQUE

First we have found that the use of a flat top instrument stand on which the patient's arm can rest, disposed of an extra assistant and as well furnishes a conveniently accessible place for our plus instruments. Also, we use heavy bath towels for draping the area as they stay in place and in addition make a warm covering for the chest. With the chest prepared by whatever method, the arm of the affected side is first drawn to the oppo-

site side, thus rotating the patient's body. A large bath towel is then placed beneath the shoulder and chest area and is allowed to hang over the edge of operating table. The arm is then brought back, at right angles to the body on the instrument table, which is covered with two large towels. The superficial towel is wrapped around the patient's arm from shoulder to below the finger tips and is secured with towel clips, while the other towel furnishes a sterile base for instruments. Another large towel is placed across the patient's body with its upper end at the level of the umbilicus. A vertical towel is then placed with its inner margin at the median line of the body and covers the entire opposite side of chest up to the chin. Finally a towel is made to cover the anesthetic frame to which it is fixed by towel clips. The angles of contact of the towels are also fixed with clips. Finally, the lower portion of the body is covered with the usual laparotomy sheet. The entire chest of the affected side is thus left exposed for the extensive dissection which is to follow.

We are convinced that in many instances the cancer can be disseminated by excessive manipulation and squeezing of the diseased breast in the course of the operative procedure. We, therefore, insist that no manipulation of the breast be permitted. Instead we seize the nipple with a large double tenaculum or volsellum by means of which the breast can be drawn about without compression during the operative manipulation.

The lower point of insertion of the pectoralis major to the humerus is located as the point from which to start the incision. From this point the incision is carried upward with a slight upward convexity over to about two fingers' breadth below the middle of clavicle. It is then curved downward to the inner side of the breast and thence down vertically to the level of the umbilicus. By undercutting a flap is raised to the inner and upper side of this incision. The flap should consist of skin and subcutaneous fat down to the depth of underlying fascia. The full blood supply is thus

¹Presented before the Western Surgical Association, Denver, Colorado, December 4-5, 1931.

preserved and as flap is thick it also provides subsequent plasticity so that the skin itself does not become fixed to the ribs. This flap is undercut beyond the median line vertically and up to the level of clavicle above. Of course it is assumed that all vessels are clamped as divided and this feature is therefore not further discussed—we pay slight attention to small oozing vessels at this time, however. The fairly large flap is thus raised.

We believe that in many instances leaking cells may come in contact with tissues left behind and become the focus of subsequent local implantation recurrences. We, therefore, deal with a cancer wound as we would with a wound in the presence of an acute infectious process from which we desire to protect the exposed area from *contamination*. The flap is therefore immediately covered with a large bath towel wrung from very hot water. Besides protecting the flap, small oozing spots close under the heat and we thus save much time otherwise consumed in trying to check and ligate every oozing spot.

We now return to the starting point for the lower portion of flap. Here the incision follows the edge of the axillary fold to the chest, skirts the edge of the breast with its concavity upward, and then turns downward to meet the inner incision near its lower extremity. This flap is likewise undercut about a hand's breadth below and in the axillary line to the edge of the latissimus dorsi behind, the undercutting being made slightly less as the procedure continues up to its starting point in the arm. This flap is now likewise raised and covered with hot bath towels.

We now mark the fibers of the pectoralis major which has been exposed by the raising of the upper



Fig 1, left. Outline on living patient of incision of original flap operation

Fig 2 Appearance in same patient of flap after operation on opposite side.

flap. In the line of the fibers we now separate, with knife or finger tips, the sternal and clavicular portion of the muscles. With the finger, the insertion of sternal portion is isolated and cut across flush with its attachment to humerus. With a curved retractor the clavicular portion is drawn upward and outward. We expose thus the costocorocoid fascia and about its middle we find descending vertically the superior thoracic vessels which are double clamped and divided. The costocorocoid membrane or fascia is incised parallel to the clavicle and, with the index finger, the pectoralis minor muscle is isolated and divided flush with its attachment to the corocoid process. The axillary space is now widely exposed. To the outside of the axillary vessels and nerves and parallel to them an incision is made down to the fixed muscles of the region. This gives a line of cleavage from which with gauze on the finger tip, the loose gland bearing tissues can be brushed off from the front of the vessels. As the brushing process pro-

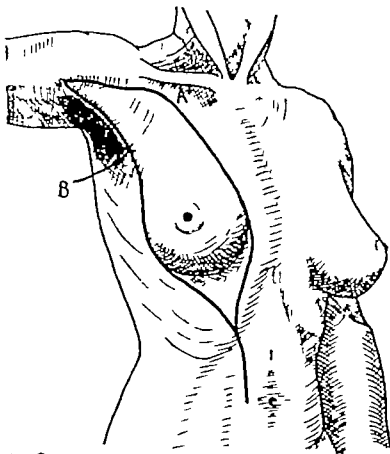


Fig 3 Outline of incision in non-flap method herein described

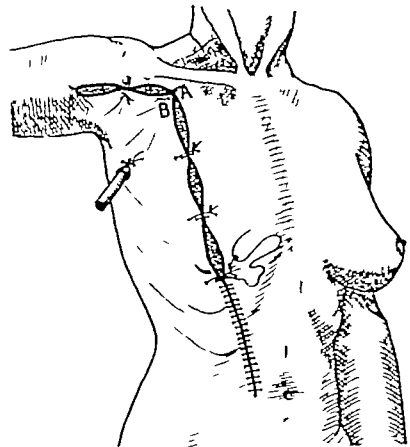


Fig 4. Outline of method of closure of the wound



Fig. 5. Appearance of wound before stitches have been removed also illustrating the correct described position of arm following operation.

ceeds inward, the branches of the axillary vessels emerge. The vessels are further isolated with forceps or the blunt point of scissors spread apart. Each vessel is picked up, double clamped and divided. They may now be ligated if desired or with other vessels left for ligation at the end of the operation. The main trunk of the axillary vein is retracted with a small curved retractor and, with blunt scissors or gauze, the thoracic are dissected from beneath the vessels. We divide transversely the fascia over the subscapular muscles and brush this fascia off with gauze. This is the route by which the lymph probably reaches the spine. A vertical incision is then made over the chest wall

well back in the recess of the wound and by brushing forward the external intercostal muscles are cleared. The axillary dissection is now completed. We pack the entire area to be left with a hot moist pad and a similar pad is likewise placed over the inner cut surfaces of the muscles and fascia with their now open lymph vessels. This step is taken again to prevent as far as possible contamination from escaped cells.

Our attention is next turned to the lymph circulation. Beginning above, the pectoralis muscle is hooked up with the finger and cut loose flush with its attachment to the sternum. The perforating branches of the internal mammary vessels will be cut and if it is remembered that they pass obliquely down it will facilitate to clamp them a little higher than anticipated. When we finish the separation of the pectoralis below we then make the fascia covering the upper end of the rectus abdominis. The fascia of the lateral chest region is divided parallel with the reflection of the lower flap and brushed upward. Thus the whole lymph and fascial supply is divided peripherally while the breast is moved about with the volsellum forceps without manipulation. The breast is lifted with the volsellum while the attachment to the chest of the pectoralis minor muscle is divided and finally the whole mass is lifted out. Each raw area after dissection is carefully kept covered with hot packs. We remove these packs in series, ligating divided vessels on clamps beneath. Most of the small oozing has been stopped but a review of the entire wound catches any persistent bleeders until the wound is dry. Some muscle oozers can be better caught in a figure-of-eight mattress suture if the exact source of bleeding is indefinite.

With the dissection complete and bleeding controlled and after all our precautionary measures,

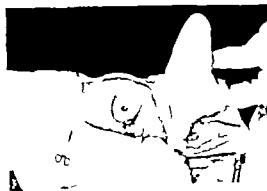


Fig. 6. Draping the field of operation.



Fig. 7. Gauze spica applied to chest and arm in position in which the arm is maintained.

we still may fear that there may yet be loose cancer cells in the wound so we treat cancer wounds as we treat no others from a large pitcher of hot water we thoroughly irrigate the entire wound while cleansing the surfaces with gauze We feel that this step gives better assurance that no loose cells will be left in the wound for local implantation and recurrent local growth

We are now ready to close the wound First, the edge of the lower flap about where it strikes the chest is brought up around the axillary vessels to a point just beneath the clavicle, as can be estimated in the illustrations These two points are caught together with a double tenaculum The remainder of the wound is approximated in similar manner with five or six tenacula at appropriate intervals As these are segmentally applied it will be found remarkable how the enormous wound is gradually approximated with practically no tension. One by one these tenacula are replaced by figure-of-eight silk worm gut sutures These sutures enter the skin about 1 inch or more from its margin, cross the wound underneath and are brought out about $\frac{1}{4}$ inch from the margin of the opposite edge. The stitch is then brought across the wound and re-enters about $\frac{1}{4}$ inch from this edge Passing underneath in the wound it finally emerges from within anterior, 1 inch from margin There is thus a short coapting loop in the skin edge supplemented by an outer tension loop Of these sutures there are usually from six to eight Before these sutures are all tied a puncture is made in the lower flap for insertion of a $\frac{1}{4}$ inch split rubber tube for drainage This is carried to the upper depth of the axilla and is fastened by suture at the point of emergence

The wound is now closed by either continuous interlocking or separate sutures, as preferred For a wound dressing we employ the heavy towels, wrung out of hot water, and applied over chest The capillarity of the dressing is favored by the moisture so that all wound drainage is delivered to the surface while the skin wound remains dry and clean This dressing is held in place by a wide gauze bandage applied around the chest and as a spica at shoulder The bandage is applied snugly to hold the flap in close contact with chest wall This bandage is applied with the arm in a vertical position and the patient goes to bed with the arm above her head This position is maintained and in 24 hours the patient is made to use the arm This position and use of the arm assures a rapid restoration of full use of arm, while if the patient is dressed with the arm down she has difficulty afterward in getting it up and thus has long continued disability

While this is apparently a minor point we have found it to be, instead, a maximum one with the patient in the utility of the arm We expect the patient in 2 weeks to be freely able to use the arm in every direction as well as she did before the operation

SOME FACTS CONCERNING ONE HUNDRED TWENTY-NINE CASES OF CANCER OF THE BREAST SEVEN YEARS AFTER OPERATION — JOHN H. OGILVIE, M.D.

The following facts have been gathered from a series of cases of cancer of the breast in the clinic of Dr Jabez N Jackson

We have selected 129 cases running from 1909 to 1924, inclusive Of the 129 cases 109 were in married women and 20 in single women The average age of the total group was 44.4 years, 11 per cent of the patients were under 30 years of age, the range of ages being from 17 to 78 years

The average duration of the disease as denoted by a mass in the breast was 2.4 years, the range in this instance being from 7 days to 8 years The average age was increased considerably by a number of cases in the 7 and 8 year period

In 62 instances the mass was in the right breast, in 67 cases in the left breast

In 72 cases skin fixation was definitely mentioned as a diagnostic feature, 24 cases made no mention of this feature, in 30 cases the skin was said to have no fixation, in 3 cases nothing definite was said about the skin Among the 72 cases in which skin fixation was present all proved to be carcinomata except 3, 2 of these latter proved to be sarcomata, 1 of the inflammatory type, and 1 proved to be a dermoid with superimposed carcinoma Of the 30 cases in which skin fixation was definitely mentioned as absent, 29 showed a mass in the breast. In the 1 case in which neither a mass nor fixation of the skin was present there was a lump in the axilla which proved to be malignant from an area in the breast which was not palpated This patient came in because of pain in the breast

In the 129 cases pain as a symptom was mentioned only 7 times

Five cases gave a history of a bloody discharge from the nipple, 2 had sinuses in the breast. Four of these 5 cases showed malignancy of ductal type while 1 showed a sarcoma superimposed upon a dermoid

Twenty-seven cases had definite involvement of the axillary structures diagnosed preceding operation, 36 had axillary metastases disclosed at operation, 14 showed microscopic metastases not suspected at operation Fifty-two cases showed no glandular involvement

Two cases in the group had a mass in the breast for 7 years and showed no glandular involvement.

In 35 cases it was thought the chances for a complete cure were good in 23 it was thought their chances were bad in all the rest no opinion was expressed.

Radical amputation was performed in all but 8 cases and in these 8 only local amputation was done. Twenty-two cases were amputated by the flap method but in all the rest the regular radical amputation was done. In those cases in which the flap method was done, the mass was situated so as to allow its use without endangering the end-result.

There were 2 deaths in 129 operative procedures: 1 complicated by thyrotoxicosis and pregnancy; the other patient dying of a postoperative pneumonia with lung abscess.

The pathological features were as follows:

	Cases
Carcinoma	97
Medullary carcinoma	4
Scirrhous carcinoma	10
Fibrosarcoma	3
Ductal type (carcinoma)	7

Twenty-one cases had combined pathological lesions of the breast.

The recurrences ranged from 1 month to 13 years and 8 months. Curiously enough, the recurrences appear to have occurred in the greater proportion of cases in two general periods, one around the 11 month period and a later period of

from 3 to 5 years. The average was slightly more than 2 years.

While it was not possible in all cases to say exactly where the recurrence occurred our percentages are as follows:

	Per cent
Lungs	41
Bones	26
Scar	3
Supradavicular nodes	10
Nervous system	8

No patients with sarcoma are alive no patient with medullary carcinoma is alive.

Of the 52 cases showing no metastases 37 patients are alive. Of the 77 cases showing metastases or those who were adjudged poor risks for radical cure, 24 are alive and well. This is a percentage of 31.17 per cent in the latter group.

CONCLUSION

1. No cases of sarcoma of the breast in this series are alive 7 years after the operation.

2. No case of medullary carcinoma is alive 7 years after operation.

3. The chance of cure by radical operation is decreased from two-thirds of the cases to less than one-third when the disease has ceased to be a local process.

4. In a series of 129 cases of malignancy of the breast 61 women are alive 7 years after the operation.

FROM THE HOSPITAL FOR CRIPPLED CHILDREN AND ADULTS

SURGERY OF THE ANKYLOSED JOINT¹

WILLIS C. CAMPBELL, M.D., F.A.C.S., MEMPHIS, TENNESSEE

ANKYLOSIS is usually regarded as a restriction of the range of joint motion, but the type under consideration at the present time is only that in which the articulation has become so completely destroyed by a pathological process within the joint that no practical motion exists or will such be possible by any manner of conservative treatment. Intra-articular ankylosis may be osseous or fibrous which is only a difference in degree and not of kind. Extra-articular contraction of the soft parts may materially limit joint function, but is not pertinent to the subject except when associated with extensive intra-articular lesions. Strong fibrous ankylosis with adhesions which permit only a few degrees of motion is clinically identical with ankylosis in which there is solid osseous fusion of the articular surfaces, with the exception that when motion persists there is often more or less persistent pain and swelling.

Until the past two decades, there has been no realm of surgery in which all forms of treatment have so completely failed as in the ankylosed joint. In a joint in which the articular surfaces had become fused, no function was possible though the nervous and muscular apparatus remained unimpaired. This was an apparition of failure to the surgeon, until by persistent effort a technique has been developed by which restoration of function can at last be furnished to a fairly high percentage in well selected cases.

Restoration of function is accomplished by an operative procedure known as arthroplasty, which is followed by a well planned after-treatment to induce nature's method of reconstructing a new joint after the normal articulation has been completely destroyed. In order, however, to secure maximum success there are many important factors which must be closely observed, and may be enumerated as follows:

- 1 Conditions for arthroplasty are more favorable when ankylosis is the result of two causative agents (a) acute pyogenic infection, (b) trauma.
- 2 All evidence of acute infection must have subsided for at least 6 months before the institution of operative procedures. This is a well known surgical maxim.
- 3 Trauma uncomplicated by infection is seldom the cause of ankylosis. Arthroplasty is more

often indicated for the relief of pain in those joints in which there is incongruity or blocking of motion by comminuted fractures.

4 In multiple ankyloses as a consequence of an acute pyogenic infection, arthroplasty is indicated and may result in restoration of motion in a number of joints in the same individual. However, the prognosis in any one joint when there are multiple ankyloses is much less favorable than when there is ankylosis of a single joint, ankylosis in other joints obviously inhibits cultivation of function in a reconstructed joint.

5 In ankylosis of a single joint caused by tuberculosis, arthroplasty or any radical measures within the joint are contra-indicated. Undoubtedly, it might be possible to obtain excellent results in some instances but the probability of relighting a latent tuberculous infection and the serious consequence thereof should be sufficient warning.

6 In those rare cases of multiple or bilateral ankyloses, as from tuberculosis of both hips or both knees, arthroplasty may be indicated as the disability is so great that the risk of relighting the tuberculous infection is justified.

7 In recent years there has been an increasing tendency to fuse or arthrodese all tuberculous joints even in children. When osseous fusion has been induced by operation in the early stage of the infection before extensive destructive changes have occurred, the eradication of the pathological process is more probable. In such cases it is conceivable that arthroplasty might be indicated. However, where there have been extensive destructive changes from tuberculosis, arthroplasty should never be considered and even in those with early fusion its advisability is not yet proved.

8 In progressive arthritis of a low grade inflammatory type, as atrophic arthritis, arthroplasty may be attempted after the process has become quiescent or arrested. Relatively good results have been secured but are not comparable with those secured after pyogenic infection or trauma, also there is less chance of restoring function.

9 The position in which ankylosis has occurred is an important factor. When ankylosis occurs in the most useful position for future function, the prognosis is much more favorable than when ankylosis occurs in malposition or luxation.

¹Read before Section of Orthopedic Surgery, New York Academy of Medicine, February 19, 1932.

10. In those in whom there has been impairment of growth from obliteration of the epiphyses or an excessive diminution in length from loss in continuity caused by the destructive process, resurfacing of the joint would not be of sufficient advantage to justify the procedure.

11. Altered osseous structure, as demonstrated by the roentgenogram may be an important factor in determining the prognosis and indications for arthroplasty. The prognosis is less favorable when the structure has been transformed for one or more inches adjacent to the articular surface. Old dense, eburnated bone forming a considerable distance in the bones extending for a considerable distance in the bones forming the articulation, is not a favorable condition usually follows an extensive violent osteomyelitis and results in low-grade bone tissue which bears the same relation to normal soft tissue fibrous near these bones poor soil for reconstruction of a joint but the danger of relighting acute infection is grave. In the knee dense bone will not form a satisfactory base for a new articulation and positively contra-indicates arthroplasty. In other joints such bone decreases the chances of success, but is a contra-indication.

12. The presence of osteoporosis or bone atrophy likewise interferes with the remodeling of the bones for the new articulation. When the position of the part will permit functional use of the member the bone structures should be restored to normal before arthroplasty is considered. This requires, as a rule, about 6 months of active use of the affected member and also weight bearing in the lower extremity. In those cases in which malposition prevents functional use, the structure of the bone can be restored to normal only by special care in gradually inducing function and weight bearing after correction of the deformity.

13. Alterations in the internal structure of the bones caused by a long period of disuse are not favorable to the construction of a new joint. In such cases there may be formation of a medulla or central canal completely transvering the bone and surrounded by cortex which has been developed by the transformation of cancellous bone into dense bone. In this event also sufficient bone may not be obtained to form a satisfactory joint. In fact, normal cancellous bone should form the basis of the new articulation. And, further the restoration of function to muscles which will have become commensurably atrophic will be difficult.

14. The age at which arthroplasty may be attempted varies somewhat in the different joints.

The most favorable age is between 18 and 30 though the procedure is permissible and justifiable in many up to the age of 55 years. Age is not so much a question of years as of the character of the tissues of the individual patient. Arthroplasty may be carried out in the knee and hip the any reasonable age though in the knee and hip the likelihood of success is lessened as age advances.

15. The prognosis is not favorable in children as the epiphyses are not fully developed and growth arrested or distorted. Callus production and granulation tissue focus more rapidly in children and there is a tendency to early adhesion or fusion. Further it is difficult to secure the co-operation necessary to induce physiological and functional adaptation in the development of a new joint.

16. The social status and occupation of the individual must be considered. Arthroplasty should be employed as a selective measure especially in the weight bearing joints. A stiff joint to a good position is more serviceable in strenuous occupation. In the jaw the procedure is always indicated as occupation has no bearing.

In fully 95 per cent of those in which the operation is indicated the etiological factor has been a pyogenic infection, the pathology of which in all prognostic organism is approximately the same, and may be described in three distinct stages, acute the subacute and the residual stage, after plasty is indicated only in the residual stage, after there has been complete organization of all tissues involved, specimens for study have only been secured under such conditions, and may be described as follows.

If the ankylosis is osseous, microscopical examination will show normal bone tissue. Microscopical examination of tissue removed from a joint with fibrous ankylosis reveals marked thinning of cartilage in places while in other areas there is hyperplasia. Phages of the cartilage in these have entirely replaced out into the joint spaces have the latter extending out into the joint other areas, the latter extending out into the joint spaces as adhesions. There is considerable osseous structure forming a root between the true cartilage on the joint side and bone below. The cartilage stains poorly and has lost its cellular elements in the superficial portion. The subchondral bone plate is frequently interrupted by phagocytes from the interosseous connective tissue. There is marked bone atrophy and halitosis and increase of interosseous connective tissue. Cellular elements are numerous in the marrow spaces, and besides the normal forms quite a number of plasma cells and lymphocytes are seen.

As many cases are first observed years after the original pathological process has subsided and after certain affections it is questionable as to the indication for operation, a careful differential diagnosis is essential. This must usually be made from the history and the roentgenogram, and often the history may not be reliable, and dependence must be placed in the roentgenogram alone. The history of an acute infectious process with sudden invasion and high temperature will usually distinguish ankylosis of pyogenic origin. Ankylosis as a complication or sequela of an acute infectious disease is also suggestive of the etiological agent, for example, an acute arthritis during the course of, or subsequent to, pneumonia that runs an intensely septic course is suggestive of pneumococcus infection. A history of prolonged convalescence with the joint remaining intensely painful and irritated for months is suggestive of infection by the gonococcus.

In ankylosis resulting from an extensive osteomyelitis there is also a history of acute onset, there are usually multiple scars, adhesions to the bone, and evidence of old sinuses extending for a considerable distance along the shaft of the bone composing the joint. On examination by palpation there will be massive hypertrophy of the shafts of the bone and often irregularity in contour of the bony surfaces.

In ankylosis resulting from tuberculosis, atrophy of the affected member is usually more pronounced than in other pathological processes. Osseous fusion is uncommon and ankylosis is usually of the fibrous type. Motion is slight and often painful and the patient may complain of joint strain. There is a history of insidious onset with an indefinite course, often extending over several years.

Syphilis seldom causes ankylosis but may induce extensive destructive changes of the articular surfaces, causing pain from incongruity. There will be a history of an indefinite process closely resembling tuberculosis, but the symptoms will be prolonged and without pain until destructive changes occur. The Wassermann test has been found a material aid to diagnosis.

In the atrophic or progressive polyarticular arthritis there is a history of low grade inflammatory process running an indefinite course often extending over months and resulting in painful and deformed joints after the process has subsided. Solid osseous fusion occurs only in the late stage of such affections. The hypertrophic type rarely causes ankylosis, but there is limited motion.

In ankylosis following trauma there will be a history of severe injury followed by a period of

disability. There may also be a change in contour of the extremity resulting from a fracture. Bony ankylosis rarely follows trauma of the large joints except the elbow.

X-ray examination. As the history and clinical findings may be obscure the diagnosis of the cause of ankylosis often depends entirely upon the roentgenogram. In ankylosis from any cause the roentgenogram determines the position and relation of the bones forming the articulation, loss in continuity, and character of osseous structure. When not inhibited by massive hypertrophy of bone circumscribing the affected area, the roentgenogram will also demonstrate the pathology in the interior of the joint and adjacent thereto, as destructive areas, osteoporosis, cavities, and sequestra.

In ankylosis resulting from acute pyogenic infection the manifestations in bone are confined to the articular surfaces and to the subadjacent bone. At the end of 3 to 6 months after the subsidence of all symptoms, the joint line may be plainly visible but narrower than normal, the extremities of the bones will show extensive osteoporosis with a very thin cortex. If the process ceases at this point, a fibrous ankylosis may result in which a line of cleavage will be permanently apparent, but more frequently there is a gradual ossification until osseous fusion of the articular surfaces is complete with an increase in density beneath the articular surfaces. Coincidentally with the intra-articular ossification there is a gradual increase in structural density and condensation of the spongy bone with slight hypertrophy in the extremities of all bones composing the joint. Also there may be a slight proliferation of the periosteum for a considerable distance along the shafts of the bones. Such hypertrophic changes cause the joint to stand out in marked contrast to the surrounding soft tissues.

In ankylosis resulting from acute infectious osteomyelitis the etiological factor may be the same pyogenic organism which may cause acute infectious arthritis but the process is diffused throughout the joint and the entire, or part of the, shafts of the bones comprising the articulation. There is massive hypertrophy of the extremities and shafts with marked increase in density which is characteristic. Even though the causative agent in osteomyelitis and arthritis is identical, the indications for operation in certain joints are totally different in the two conditions as above emphasized.

The X-ray rarely demonstrates osseous fusion in tuberculosis. There will be definite irregular dark areas of destruction and often destructive

changes along the joint space which are most suggestive.

In low grade infectious arthritis, osseous ankylosis is exceedingly rare. The process often terminates in extensive destructive changes with hypertrophy and erosion of the joint surfaces, though seldom in solid fusion. Ankylosis is usually fibrous. Differentiation may not be possible by the roentgenogram from acute pyogenic infections of a mild degree or from a typical tuberculous joint, until exploration is made. The roentgenological appearance in syphilitic arthritis is well known and characteristic.

In arthritis of the hypertrophic type or osteosyphilitic arthritis is well known and characteristic. In arthritis of the hypertrophic type or osteosyphilitic arthritis is well known and characteristic. In arthritis of the hypertrophic type or osteosyphilitic arthritis is well known and characteristic.

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When ankylosis will demonstrate irregular callus roentgenogram will demonstrate irregular callus from literature there is often confusion between arthroplasty and excision especially in the elbow joint. Excision is merely the removal of sufficient bone to induce a pseudo-arthritis, whereas arthroplasty is the reconstruction of all the component parts essential to function. The operative technique of arthroplasty may be divided into (1) the plastic adjustment of the soft parts, (2) the reconstruction of bone (3) the interposition of tissue.

The plastic adjustment of soft parts In planning the operation the position in which ankylosis has occurred must be taken into consideration as well as the relation of the articular surfaces and the contractures of tendons, fasciae, nerves, and vessels. Undue tension must not be placed on the tendons, fasciae, and capsules must be lengthened by plastic adjustment when contracted to permit free function of the articulation. The object should be the re-arrangement of all contracted soft tissues to comply with the demands of restoration of function. Active function will be re-established earlier if all structures are conserved. No tissue should be dissected unnecessarily usually tendons should not be divided until the bone has been severed, as often very large tendons may be of sufficient length to permit a fair range of motion after all scar tissue has been removed, and the articular surfaces are remodeled.

As in the bones great care should be taken to impair the circulation to the articular surfaces as little as possible. Stripping of the periosteum with soft tissue attachment in order to correct deform-

ity is to be especially avoided, as irregularities from aseptic sequestra may later occur and defeat the purpose of the operation. If deformity cannot be corrected by severance of the extra-articular tissues and capsule a two stage operation is indicated.

Reconstruction of the bone The fusion of the bones, whether osseous or fibrous, should be entirely severed under direct inspection. Great force should not be used in separating the articular surfaces as crushing of the surfaces and fractures may occur. The amount of bone removed varies in each joint and according to the different conditions found in the same joint. An amount should be excised sufficient to permit easy play of the joint on manual traction, though under no circumstances, regardless of the contracture of the part, should excision be so extensive as to prevent the formation of an adequate foundation for satisfactory articulation. For example, should all the expanded lower extremity and condyles be removed from the humerus, only the shaft would articulate with the bones of the forearm and a flail pseudo-arthritis would result. This, in reality, would be an excision and not an arthroplasty.

The technique varies as does the mechanism of the joints. In some of the joints it is best to reconstruct a more simple articulation than the original normal joint. For instance, in the knee, the integrity of the spine shallow tibiocondylar notch, and the condyles and intercondylar notch of the femur cannot be so well maintained as the construction of a simple hinge joint with one condyle and one shallow recurring tuberosity. In such a joint as the hip the normal ball and socket is the simplest and should be employed when possible.

Interposition of tissue It is possible to restore function without interposition of tissue between the articular surfaces, but the chances of success are much less than when no material is interposed, as has been demonstrated by experience. The object of interposing material is not alone to prevent union of the surfaces but to induce the formation of a new synovial membrane, or substitute therefor. In consequence a double layer of tissue should be placed between the articular surfaces, and so anchored as to permit free play of the articulation within normal range. This thus reproduces the primary embryological joint. Undoubtedly in the past failure has often been due to efforts made solely to prevent fusion without due consideration of physiological principles. The material interposed should be autogenous, the most adaptable from the standpoint of tolerance and texture is undoubtedly the fascia lata from

the outer aspect of the thigh just above the knee, where a sheet of sufficient dimensions can always be secured. In some of the smaller joints, however, as the fingers and small wrists the fascia may be taken from the inner aspect of the thigh where it is much finer and thinner. The fascia should be interposed with the rough external surface applied to the raw surface of the bone, while the smooth, glistening, internal surface lines the interior of the joint. The loose areolar tissue applied directly to the open marrow spaces of raw bone is thus conducive to early vascularization, while the smooth deeper surface permits early movement of the articular surfaces.

A microscopic examination of the fascia lata demonstrates that the deep smooth fibers are closely packed resembling tendon tissue, which becomes more loosely constructed as the outer surface is approached. A fluid is observed beneath the fascia on removal which permits the free play of the muscles, but this must be normal lymph as no endothelial cells could be demonstrated on the deeper surface.

The technique in the different joints has been previously described in former contributions, in those joints more adaptable to arthroplasty, in consequence only a general discussion of some of the important details will be considered. In the jaw no material is interposed and the operation is more of an excision as the normal condyle and ramus maintain the space after removal of bone when only one side is involved, and when bilateral the force of gravity acts in the same manner. In all other joints the double layer of fascia is interposed as already described. In the knee joint a portion of the posterior crucial ligament can usually be conserved which maintains circulation to the internal condyle. Great care should be taken not to interfere with the circulation to the external condyle by stripping posteriorly the periosteum and soft parts from the bone and severing the external ligamentous attachment. After the operation the internal lateral ligament may be elongated, and should be shortened by a mattress suture. Also in the knee it has been found unnecessary to sever the quadriceps tendon, as sufficient space is maintained for joint function after the usual amount of bone has been removed and the surfaces reconstructed. In the hip joint the ligamentum teres must be severed, but the operation should be carried out through the Smith-Petersen incision without stripping the attachments of the capsule from the neck, thus preserving the circulation from the so called epiphyseal and periosteal vessels. It has been found that wide exposure with removal of soft tissues may cause necrosis

of the head with later dissolution unless these principles are meticulously carried out. The head should also be made as large as commensurate with the bone which remains.

In the ankle and in other joints, as the shoulder, when compensatory function was possible arthroplasty has not been employed except when adjacent articulations were also ankylosed, but in recent years arthroplasty has been successfully employed in three ankles in which only that joint was the victim of bony ankylosis. The operation was carried out by a long external lateral incision with the interposition of a double layer fixed by suture to the posterior capsule. So far these patients have not complained of pain and a sufficient degree of motion was secured to restore elasticity to the gait, which was approximately 20 to 30 degrees. Arthroplasty of the fingers has not restored the free movements desired, but in some instances there has been material improvement, possibly 50 per cent of function.

The *after-treatment* is most important and is instituted within one week by inducing voluntary muscular action as contracting the quadriceps muscle. At the end of 2 weeks active and passive motion is continuously induced and gradually increased. Care is taken that active motion is commensurate with passive motion, as it is possible to cause excessive movements, with stretching of important ligaments and false motion. Also the structure of the bone must be restored to normal as function is increased, as there may be compression of osseous surfaces in which osteoporosis persists. In the weight bearing joint this is accomplished by apparatus which gradually permits the weight of the body on the part to be increased. Even after apparatus has been discarded more vigorous exercises should be enforced to cause further condensation of the bone, as in four knees there was a subsequent fracture of the lower extremity of the femur from comparatively slight trauma, but this can and should be avoided by observing the physiological principle of functional adaptation. In these cases the fracture had healed without further impairment of function or complication.

As previously stated, unless a joint can be restored in which there is approximately normal endurance, a stiff joint in a good position is more serviceable, however, nearly normal joints can and have been secured in a sufficient number of cases, as previously reported as to the end-results in individual joints, to justify the procedure.

There has been much speculation as to the nature of a joint after the evolutionary process of

reconstruction following arthroplasty and this factor was demonstrated in the Sir Robert Jones Lecture, October 18, 1930. Conclusions were drawn from several factors which may be enumerated as follows: (1) "spontaneous arthroplasty" after destructive processes in joints (2) ununited fractures (3) successive roentgenograms after arthroplasty (4) biopsy of joints in which function had been secured by arthroplasty.

"Spontaneous arthroplasty" is the reconstruction of a joint by natural processes destroyed. Such a joint has been completely destroyed. The termination of an acute infectious process is not infrequently observed, especially in the hip joint, as illustrated by the following case history

A woman, aged 45 years, applied for treatment at the Hospital for Crippled Adults, on account of disability and pain in the hip joint which resulted from an acute infectious arthritis occurring at the age of 5. The patient walked with a decided limp, the left hip was flexed 30 degrees. There was about 30 degrees free motion in all directions. The roentgenograms demonstrated a very irregular joint with marked proliferation and condensation. The diagnosis was the residual stage of acute infectious arthritis, with subsequent osteo-arthritis, due to constant use of an incongruous joint. An arthroplasty was performed October 4, 1931. On incision into the joint, the acetabulum and head of the femur were found to be irregular and scattered osteophytic formations about the margins and scattered areas of degeneration and fibrillation of the synovial ligamentous tissue had entirely disappeared. The synovial membrane was largely substituted by a specimen of dense tissue. The microscopic examination of specimen removed from the acetabulum and from the head of the femur demonstrated a layer of dense fibrous connective tissue beneath which was a layer of fibrocartilage. There were definite degenerative changes in the cartilage beneath the cartilage was the supporting normal spongy bone.

Sections were also made from a number of ununited fractures with pseudo-arthritis excised at the operation. The tissue structure is almost identical to that in a spontaneous arthroplasty. There are three more or less defined strata, namely from within outward a dense fibrous layer a stratum of atypical cartilage and the supporting bone. The articular surface apparently arises from two sources the exposed marrow spaces and the transplanted fascia lata if the latter remains viable otherwise from the marrow alone. As cartilage cells have been demonstrated in the deeper layers of the synovia and capsule, it is possible that the articular surfaces could be derived from that source.

Biopsy has been carried out in a number of joints varying from 6 to 18 months after arthroplasty which demonstrated approximately the same process as after spontaneous arthroplasty and ununited fracture. The capsule at the end of one year is much thicker than normal, and the joint cavity approximately one-half the size of the

normal joint. There is usually joint fluid present. The surface may be covered with a layer of these very closely resembling the interposed fascia lata. A section from the surface demonstrated by the microscope a superficial layer of dense fibrous tissue with a vascular supply which appeared to be the interposed fascia lata, or a substitute thereof. Beneath this is a layer of cartilage which is supported by spongy bone. The superficial layer is approximately from 50 to 100 microns in thickness the fibrocartilaginous layer is approximately from 500 to 1,000 microns in thickness the osseous layer is, of course, continuous with the articular structure of the bones which comprise the articulation. In one case synovial villi were demonstrated, but this could not be accepted as conclusive as it may have been the remains of the former normal joint. In some of the cases examined there were several bursae or hygromata and in some there were fibrous adhesions across the articular surfaces. In those, after the lapse of one year the fibrous layer showed evidence of disappearance by absorption and substitution of fibrocartilage so that in time the entire joint was invested by a layer of more or less atypical articular cartilage.

In spontaneous arthroplasty pseudo-arthritis, and often arthroplasty the evolutionary process is approximately the same and is brought about by friction between osseous surfaces. A pseudo-arthritis differs materially from an arthroplasty or from a joint which nature has salvaged by spontaneous arthroplasty in that there is no muscular apparatus especially arranged to secure function. Evidently however free movement with friction induces the same process.

Wherever motion can be maintained between osseous surfaces, there will develop an evolutionary process of healing with the formation of a new joint which is nature's method of repair. As time advances the tissues will become, from usage, more highly specialized. The fascia lata, in all probability entirely disappears, or is substituted by dense fibrocartilage, but it is very doubtful whether true hyaline cartilage is ever reproduced. Thus the process is simply nature's method of repair, and arthroplasty must be regarded as a method which may induce normal reparative process.

Roentgenograms. Much information can be secured by successive roentgenograms after arthroplasty. About 500 films of arthroplasties have been reviewed, the intervals at which they were taken ranging from 1 to 10 years after operation. There are some variations in findings, depending upon the function of the joints in question. The

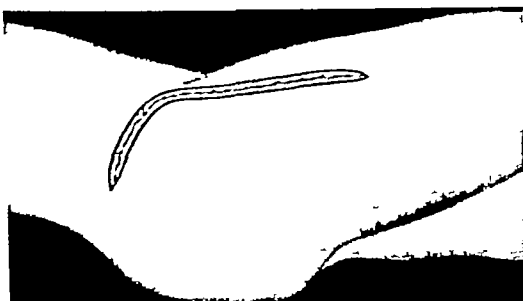


Fig 1 Skin incision for arthroplasty of hip

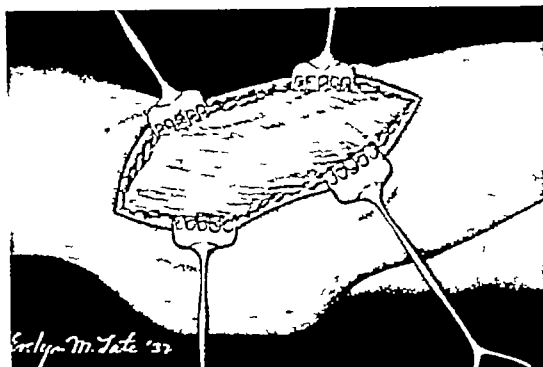


Fig 2 Exposure of muscles

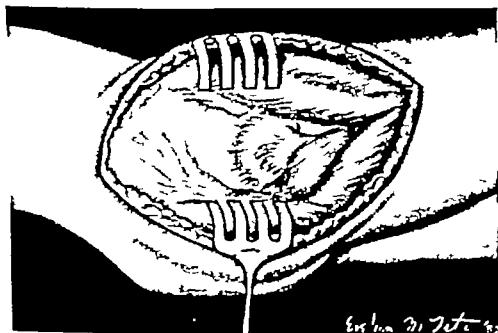


Fig 3 Complete exposure of ankylosed hip, care being used not to remove any more attachments of the soft tissues about the neck of the femur than is absolutely necessary

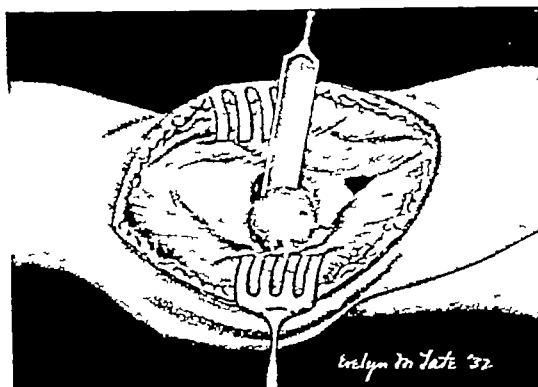


Fig 4. Excision of ankylosis and removal of the head, care being used to alter the contour of the head as little as possible.

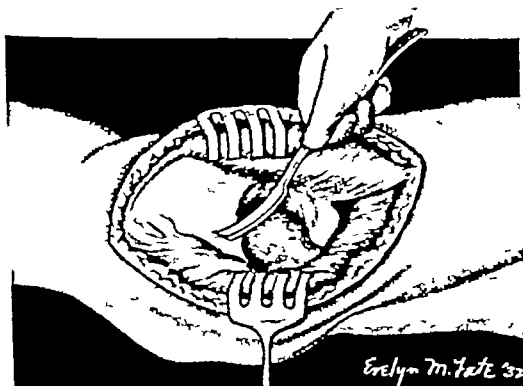


Fig 5 Smoothing off the head with rasp, leaving the head large and globular

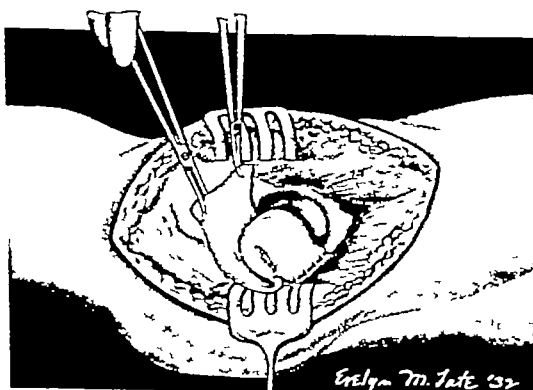


Fig 6 Interposition of free fascia lata placed to cover the head and acetabulum thus making a double layer or practically closed sac when the reduction is made.

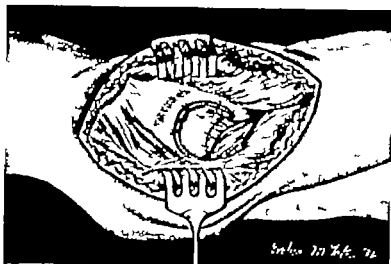


Fig. 7 Complete reduction; new joint completely fixed with fascia lata.

evolution of functional adaptation, as would naturally be expected, is more pronounced in the knee and the hip than in the non-weight-bearing joints. The dimension of the joint space is less than normal, especially in weight bearing joints. The relation of the articular surfaces to each other remains unchanged, except in a small number in which the stamina of the ligaments was impaired and in those in which gross irregularities had occurred. In a majority the contour of the articular surface was even and smooth. In some there was a definite irregularity. In a small number of knees

there was a punched-out area or cavity on the lateral aspect of the articular surfaces of the femur corresponding to the normal external condyle. In two or three there were similar but less marked changes in the lateral half of the articular surfaces on the tuberosity of the tibia. Gross irregularities in the head of the femur were occasionally observed, and in one instance there was total disappearance of the head and neck. Compression of the articular surfaces was also present at times. Those gross irregularities described were probably due to impairment in circulation at the time of operation. Successive roentgenograms demonstrated compression of the articular surfaces to be due to functional use, as weight bearing, before the structure of the bone had been sufficiently restored. In joints not bearing weight unrestricted use with impaired ligaments may also cause such irregularity but not to the extent demonstrated in the lower extremities. As has been proved by experience, these defects can be obliterated largely by avoiding impairment of circulation at operation by properly regulated use and by restricted weight bearing until the structure of the bone and the musculature has been restored.

The structural changes after arthroplasty are as follows. At the end of 3 weeks osteoporosis is present, as denoted by the characteristic mottling, which gradually increases until the effect of active use is apparent which is usually in about 3 months. At this time there is gradual restoration of structure as denoted by the appearance of new bone trabeculae. At the end of 1 year the bone structure should be approximately normal. About this



Fig. 8, left. Bony ankylosis of hip following infectious arthritis.

Fig. 9 Same as Figure 8, 4 years after arthroplasty. The contour of the head of the femur and the acetabulum is well adapted for efficient function and the range of motion is practically normal.



Fig 10 Roentgenogram of hip, 3 years after arthroplasty. Note the irregularity in contour of the head of the femur which has occurred as the result of aseptic necrosis. Function of the joint, however, is excellent.

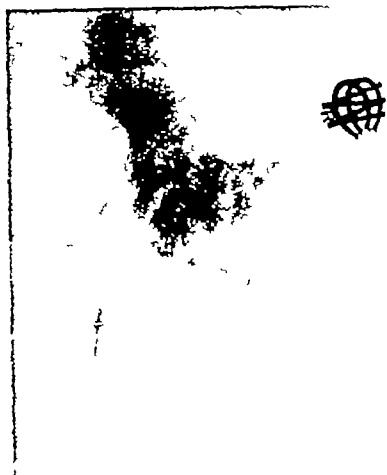


Fig 11 Roentgenogram of hip, 12 years after arthroplasty. There is considerable new bone proliferation about the joint which, however, does not interfere with good function.

time, approximately one-fourth of an inch below the articular surface, there appears a fine line of condensation with bone trabeculae at right angles to the shaft, this gradually increases for the ensuing year, after which it remains stationary. This is probably the index that restoration has been accomplished as far as possible. As years go by, the rearrangement of the osseous trabeculae, along the new lines of pressure becomes evident as in

normal extremities. Of course, there is no arbitrary period for such development, which largely depends upon the co-operation and the muscular resources of the individual.

Pronounced bone proliferation, as evidenced by formation of outgrowth from the articular margins or osteophytes, was present in approximately 40 per cent. In 25 per cent there was only slight



Fig 12

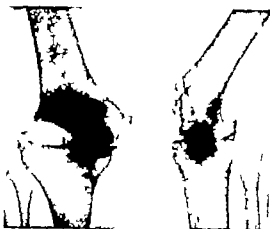


Fig 13

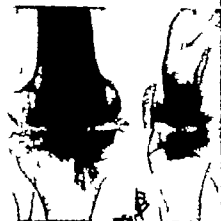


Fig 14

Fig 12 Bone ankylosis of knee following acute infectious arthritis.
Fig 13 Same case as in Figure 12, 3 years after arthroplasty. Anteroposterior view.
Fig 14 Same as in Figure 12, lateral view. Note regularity in contour of articular surfaces.



Figs. 5 and 6. Roentgenogram of knee 3 years after arthroplasty. A teroposterior and lateral views. A portion of the external condyle of the femur has been absorbed leaving a large defect. The stability of the joint is good and the clinical result excellent.



Figs. 7 and 8. Roentgenogram of knee 1 year after arthroplasty. Anteroposterior and lateral views. Articular surfaces are irregular and there are hyperplastic changes in the new joint. The knee is stable, movable and painless.

proliferation and in 35 per cent no reaction whatsoever. This reaction depends entirely upon the extent and the degree of involvement of bone by a pyogenic process. In other words, on the degree of osteomyelitis as evidenced by condensation of bone. In those patients in whom the infection was entirely confined to the joint and the structures of the bone had remained normal there was no reaction. This reaction, however, does not bear any material relation to the functional result unless there has been an extensive osteomyelitis. In many apparently normal or serviceable joints, after various pathological processes, such changes are known to occur and are frequently observed.

The stamens of the contour of the articular surfaces, as illustrated by the gross irregularities observed in the roentgenogram, is due to impairment of circulation, bone atrophy or osteoporosis and impairment in quality of the bone structure. The articular extremities being free, the blood supply is derived solely from the attachment of the adjacent soft structures. The joint surfaces do receive slight nourishment from joint fluid, but not sufficient to have an appreciable effect. During operation, if there is gross detachment of the bone from the soft structures, circulation will be impaired and areas of the articular surfaces may undergo aseptic necrosis with sequestration or absorption. On the other hand, the soft structures may be reattached with reestablishment of the blood supply before such occurrences take place. There is a close analogy to the loose bodies in

joints, the bone graft and terminal fracture extremities. The loose body especially the caused by the condition known as osteochondrodiacans, is in all probability due to trauma impairing circulation to the articular media in posterior cruciate ligament, which supplies a mass on the internal condyle of the femur. Aseptic necrosis of a particle of bone with cartilage investment is exfoliated into the joint. A cross section of this body after it has remained in the joint for a long period of time will all living tissue on the exterior but necrosis will. It has received nourishment only from the joint fluid. However if by chance the loose body comes attached to a villus or a fold in the synovial membrane, the particle becomes revascularized there being more rapid proliferation and restoration of the interior. The bone graft also depends on early revascularization in the same manner. Function is to be restored. Terminal fracture often do not unite as illustrated by the frequent occurrence of non-union in such locations as the neck of the femur and the external condyle of the humerus. This non-union is caused by the severance of the circulation by fracture and the fact that a large portion of the terminal fragment, the articular surface, is devoid of blood supply.

The gross irregularities after arthroplasty demonstrated by the roentgenogram, are not always incompatible with excellent function as often observed. Similar irregularities in joints of good function are demonstrable often, for example after a loose body caused by osteochondritis

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The case last cited is a very good example of the union of the distal end of the middle phalanx of the middle finger with the proximal phalanx of the ring finger, which is a very rare occurrence. In such cases, the middle finger is usually shorter than the ring finger, and the union is usually complete. The union may be complete or incomplete, and the middle finger may be shorter or longer than the ring finger. In this case, the union is complete, and the middle finger is shorter than the ring finger. The union is usually complete, and the middle finger is shorter than the ring finger.

Proximal phalanx	100	100
Middle phalanx	100	100
Distal phalanx	100	100
Union	100	100

These figures will probably be made in the treatment of the fracture of the metacarpal and the phalanx when the same consideration is given to these small bones as is given to the long bones of the body. At the outset, therefore, we wish to present the functional anatomy involved in fractures of the metacarpals and the phalanges.

The proximal end of the middle phalanx of the middle finger is usually shorter than the proximal end of the proximal phalanx of the ring finger. The union of the middle phalanx of the middle finger with the proximal phalanx of the ring finger is usually complete, and the middle finger is shorter than the ring finger.

Movements of the fingers. The separate series of movements occur in relation to the articulation of the fingers. Flexion and extension (at the metacarpophalangeal and interphalangeal joint), and abduction and adduction (only at the metacarpophalangeal joint). The movements and the muscles concerned are given in the following table:

Flexion	Extension
Flexor digitorum profundus	Extensor digitorum communis
Flexor digitorum superficialis	Extensor digiti quinti proprius
Palmaris profundus	Interossei (acting on the
Interossei (acting on the	Lumbricals (interphalangeal
Interossei (acting on the	articulations)
Abduction	Adduction
Flexor digitorum profundus	Extensor digitorum communis
Flexor digitorum superficialis	Extensor digiti quinti proprius
Palmaris profundus	Interossei (acting on the
Interossei (acting on the	Lumbricals (interphalangeal
Interossei (acting on the	articulations)

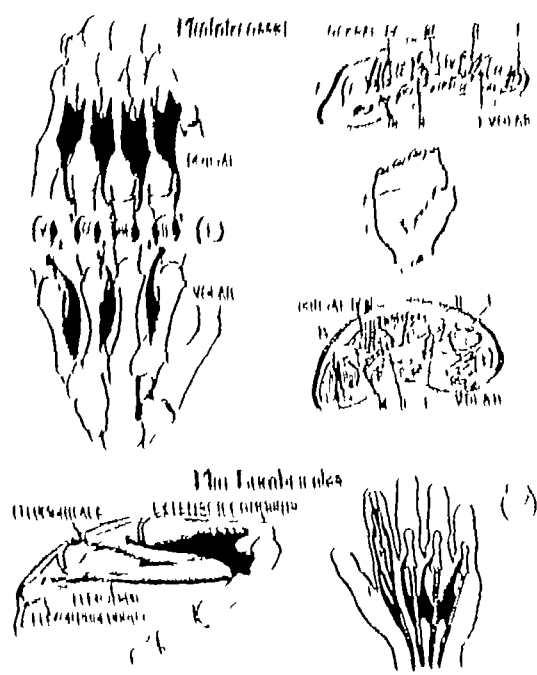


Fig. 1. Arrangement of intrinsic musculature of the hand.

Flexion is more powerful and complete than extension of the fingers. The flexor digitorum profundus alone acts on the terminal phalanges, the flexor sublimis and the flexor profundus together flex the proximal interphalangeal joint, flexion of the metacarpophalangeal joint is affected by these muscles assisted by the interossei, lumbricals, and flexor digiti quinti brevis. Extension of the phalanges is brought about by the united action of the extensors of the digits, the interossei, and lumbricals. Extension of the fingers at the metacarpophalangeal joint is produced solely by the long extensor muscles. Separate extension of the index finger only is possible, the three inner fingers can be completely extended together only because of the connecting bands joining the extensor tendons on the back of the hand.

The arrangement of the interossei and lumbrical muscles and the insertions of the flexor and extensor tendons are illustrated in Fig. 1.

Fractures of the distal phalanx. The terminal phalanx is attached only at its proximal end to the middle phalanx. Its distal portion is free and not subject to the action of either the intrinsic or extrinsic muscles. It is here that considerable crushing, or fragments may occur with but slight displacement (Fig. 2). Fractures involving the

secans has been removed, a large cavity may remain in the internal condyle of the femur without impairing function also it is possible that many of the irregularities observed in the roentgenogram may be filled in with dense fibrous tissue the defect being more apparent than real. Unfortunately no opportunity has been offered to prove by biopsy the status of such joints.

Depression of the articular surfaces as a result of too early compression by weight bearing has been observed, but can be prevented by the routine after treatment as described. In those cases in which the quality of the bone is deficient as manifested by excessive condensation, sequestration and disintegration joint irregularity may occur regardless of the after treatment. Unless, however, this irregularity is excessive, it is usually not incompatible with good function.

As a basis of this discussion the records of 325 arthroplasties have been reviewed. The results in the more favorable joints have been previously reported which, however cannot be estimated grossly as there are numerous factors, as previously enumerated which may affect the individual case, for instance, malformation, impairment of structure and causative agents, and also the

evaluation of these results must be made in terms of function and endurance and not mere motion. Sufficient time has elapsed to denote the effect of wear and tear of actual usage in some instances as long as 15 years since operation. In 1937 I made a painstaking analysis of 27 knees in which good function had been secured and in which from -3 to 8 years had elapsed since operation. Since that time these cases have continued in the same status. The type of joint secured cannot be regarded as a reproduction of the normal articulation but an excellent substitute which will often replace to a satisfactory degree normal function and endurance and in many instances decrease severe disability.

In conclusion I desire to emphasize the gradual evolution in operative technique to conform to the physiological principles involved. This is well illustrated in arthroplasty of the hip and knee. The operation must be carried out with minimum impairment of circulation, in consequence the procedure must be so planned that the soft parts are detached as little as possible from the articular extremities. These principles are not alone involved in arthroplasty but in all surgery of bones and joints.

proximal portion of the terminal phalanx are subject to the action of the flexor profundus tendon and the extensor communis tendon. A fracture here may develop a varying degree of dorsal displacement of the proximal fragment (Fig 2b). Occasionally, the entire proximal fragment may be evulsed (Fig 2c).

Fractures of the middle phalanx. Fractures of the middle phalanx owe their displacements to the action of the flexor digitorum sublimis. This muscle ends in a tendon which separates into two portions, which insert one on either side of the

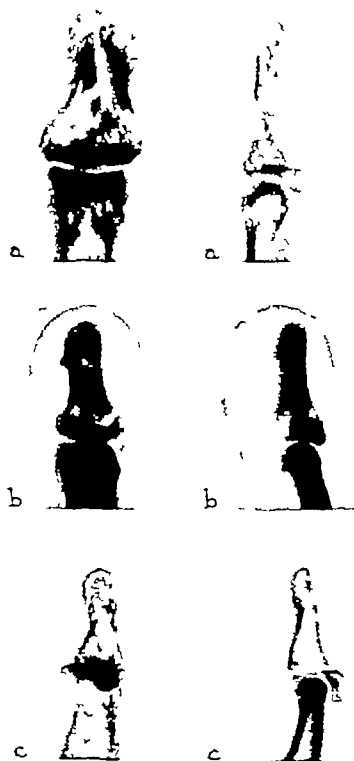


Fig 2 Fractures of the distal phalanx.



Fig 4 Volar spur resulting from fixation of fractured middle phalanx on a straight splint.

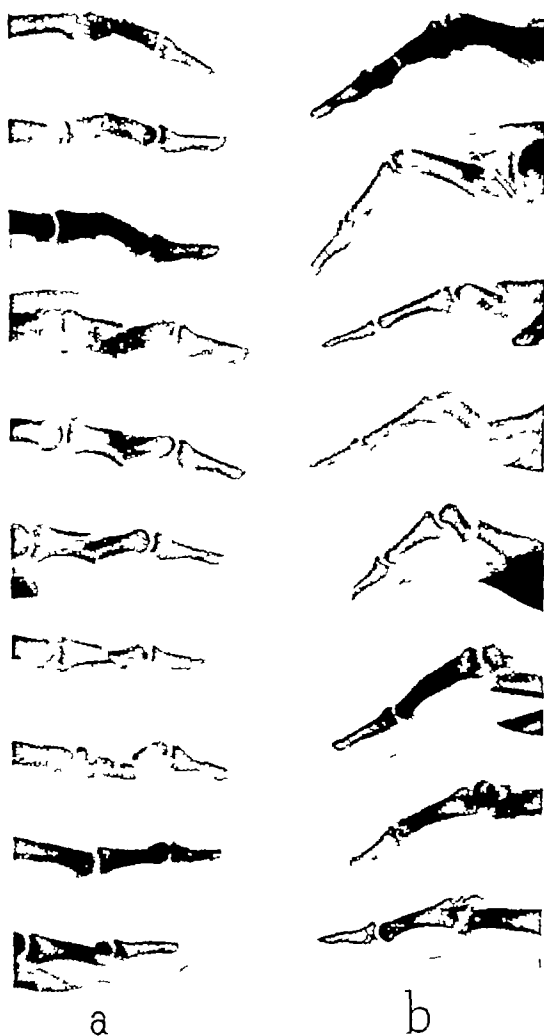


Fig 5 a Fractures of the middle phalanx at various levels, b, fractures of the proximal phalanx at various levels.



Fig 5 Restoration of natural arc by the use of a curved splint.

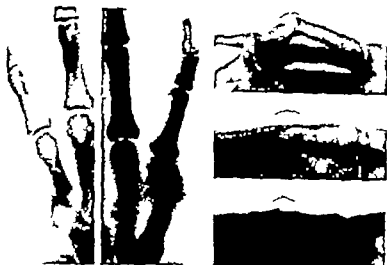


Fig. 6. Fracture of metacarpal bones showing flexed position with dorsal projecting spur

middle phalanx at approximately the mid portion. The deformity produced will depend on the location of the fracture site. If this site is distal to the insertion of the tendon, there occurs a downward position of the proximal fragment and upward displacement of the distal fragment. When the fracture site is proximal to the tendon insertion there is produced downward displacement of the distal fragment with an upward position of the proximal fragment. Examination of the accompanying diagrams showing different sites of fracture of the middle phalanx illustrates this point (Fig. 3a).

Failure to take into account these two types of displacement of fragments will result in a failure to correct the deformity. When a straight splint is used for the second type of deformity there results most commonly a downward projecting spur which interferes with flexion of the distal phalanx (Fig. 4).

In the second type adequate fixation can be had by bringing the distal fragment into line by the use of a curved splint restoring the fragments to the natural arc, which was present before fracture took place (Fig. 5).

Fractures of the proximal phalanx. The resulting deformity when fracture of the proximal phalanx occurs is fairly constant regardless of the site of fracture (Fig. 3b). As can be seen in the accompanying illustration downward displacement of the proximal fragment is brought about by the action of the interossei muscle while upward displacement of the distal fragment is due to the action of the lumbrical muscle. Here again

fixation on a straight splint will maintain the deformity and result in impaired function. When the distal fragment is brought into line with the proximal fragment by fixation on a curved splint, a minimum of deformity will result.

Fractures of the metacarpals exclusive of the thumb. Fractures of the metacarpals usually result in typical deformities characterized by shortening of the length of the bone due to bowing of the fragments. There is a dorsal projection at the site of fracture and volar displacement of the metacarpal head (Fig. 6). This configuration is the result of the action of the interossei muscle which is a flexor of the proximal phalanx. The distal fragment of the metacarpal being attached through the metacarpophalangeal joint to the proximal phalanx assumes a flexed position.

SUMMARY

A summary of the metacarpal and phalangeal deformities with general principles of management may be found in Figure 7. A great amount of detail might be incorporated relative to the management of individual fractures of the metacarpal and phalangeal bones, but the purpose of this paper is to call attention principally to the mechanisms involved in producing the deformities, rather constantly found in these injuries, and also to point out the principles concerned in overcoming these deformities.

In a study of fractured bones, Zupping¹ made use of fundamental geometrical principles in explaining and designing the use of various mechanical applications of force to produce correction of

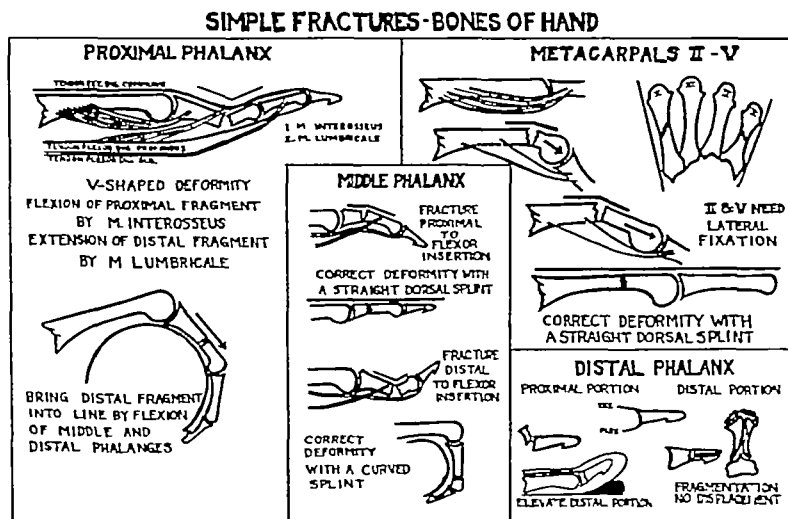


Fig 7 Illustrating mechanisms of deformities produced by the action of the intrinsic muscles and tendons with suggestions of means for overcoming these deformities.

the deformity. Practical application of Zup-pinger's studies is exemplified in the ingenious method of application of a malleable volar splint applied to the finger in extension and firmly secured by adhesive material. The splint is then bent in a curved manner carrying the finger in an arc of palmar flexion. This maneuver increases the length of the dorsal arc thereby producing ex-

tension as well as affording a natural curved support for the fractured member.

The management of compound fractures will not be undertaken in this brief discussion because the fundamental principles of management must often be sacrificed because of the concomitant injury to soft parts with impending or present infection.

FRACTURES OF THE JAW

FREDERICK A. FIGI, M.D. F.A.C.S., ROCHESTER, MINNESOTA

Section on Laryngology, Oral and Plastic Surgery, The Mayo Clinic

AN increasing number of fractures of the jaw is being seen at the present time due largely to transportation and industrial accidents. Many of these fractures are necessarily taken care of by dentists and general surgeons. For their consideration a review of the symptoms, treatment, complications, and prognosis of such lesions is presented.

Fractures of the jaws may result from either direct or indirect violence. Dental extractions, surgical removal of impacted molar teeth or of any of the various benign or malignant tumors occurring about the jaws, may be responsible for fractures or they may occur spontaneously secondary to these neoplasms or to osteomyelitis (Figs. 1 and 2). Less commonly the patient's general condition, that is, the presence of rickets or of osteomalacia, may be the underlying factor. The mandible is more frequently fractured than the upper jaw because of its structure and greater vulnerability. A high percentage of fractures of the jaw is compound, usually communicating with the mouth and many of them are comminuted.

The symptoms and signs are in general those of fracture elsewhere in the body. Local pain, ten-

derness, loss of function, swelling, hypermobility, crepitus, and ecchymosis are usually present. The most uniform clinical observation, and the most reliable from a diagnostic standpoint, is displacement with accompanying malocclusion of the teeth. This is readily evident on comparing the median line of the lower jaw with that of the upper jaw. It is due to foreshortening of the fractured ramus or condyle and is always to the side of the break. With bilateral fracture of the mandible there is drooping of the anterior segment and the patient is unable to approximate the anterior teeth (Fig. 3). In most cases corroborative roentgenological evidence is relied on in making a positive diagnosis of fracture of the jaw. A negative roentgenogram is at times obtained in cases presenting positive clinical evidence of fracture, due to perfect apposition of the fragments and the superimposition of other bony structures.

Fractures of the jaws bear the possibility of serious complications. These may be the direct result of the trauma responsible for the fracture or they may be due to infection, most commonly from the secretions of the mouth. Of the immediate complications those associated with fracture



Fig. 1. Left. Fracture of mandible resulting from an osteoclastic attempt to remove solid odontoma, under the mistaken impression that it was an impacted molar tooth.
Fig. 2. Mandible immobilized with interdental wires after the odontoma had been removed. The fracture healed promptly although non-union had been anticipated.

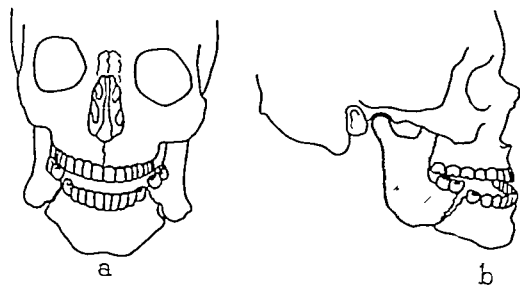


Fig 3 Sketch made from roentgenogram of bilateral fracture of horizontal ramus of mandible of a man, aged 25 years. Drooping of the anterior segment may be noted.



Fig 4 Wide-open bite due to dislocation of right condyle complicating fracture of the left mandible. The patient came under observation $3\frac{1}{2}$ weeks following treatment of fracture complaining of inability to close his jaws.

of the superior maxilla are likely to be more serious than those of the mandible. Fractures of the base of the skull frequently accompany such injuries. The complications of fracture of the mandible include perforation of the glenoid cavity, either through the middle cranial fossa or the external auditory canal, primary or secondary hemorrhage, and dislocation of one or both condyles. The last condition may readily be overlooked for a time following the fracture due to the false ankylosis resulting from trauma to the muscles of mastication (Figs 4, 5, and 6). Osteomyelitis and submaxillary or cervical phlegmon frequently develop as a result of mandibular fracture. These complications are more likely to occur with comminution or when a dental root is present in the line of fracture. They can often be prevented by inserting a drain externally down to the line of fracture at the time of fixation, as suggested by Blair and Ivy. Late complications are non-union and bony ankylosis of the temporomaxillary articulation, the possibility of the latter

being increased in cases of fracture of the condyle.

Should more serious injury accompany fracture of the jaws or the patient be in shock, these conditions must first receive attention, otherwise immediate reduction and fixation are carried out. In cases coming under observation several days following the injury, so much inflammatory reaction and infection may be present that manipulation for the time being is inadvisable. In this event hot irrigations into the mouth and applications of warm compresses are employed until the process subsides. Not infrequently a phlegmon will develop at this time or later following reduction of



Fig 5, left. Retouched roentgenogram of anterior dislocation of the right condyle. Same case as shown in Figure 4.



Fig 6 Retouched roentgenogram of fracture of horizontal ramus of left mandible. Same case as shown in Figures 4 and 5.

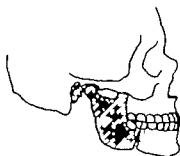


Fig. 7

Fig. 7. Drawing of roentgenogram of fracture of the mandible with fractured molar tooth. Dental structures in or immediately adjacent to the line of fracture are one of the most common causes of delayed union. Such teeth should be removed if the time of immobilization unless removal is impossible without undue trauma.

Fig. 8. Method of immobilizing fractured mandible by means of interdental wiring. Ivy's modification of this procedure. An eyelet is made by twisting the middle of the wire prior to inserting the doubled strand between the



a

Fig. 8

Fig. 9. Method of immobilizing fractured mandible when only a few teeth remain in either alveolar process. The pilable metal bars are wired directly to the teeth and rounded knobs on these bars are then united by means of wire loops.



Fig. 9

teeth. The wire completing the loop about the teeth as so placed in relation to this eyelet that traction on the latter tends to tighten the loop. b Fractured mandible before wiring.

b

the fracture and require drainage. Bits of detached bone or dental structures in the line of fracture are removed at the time of reducing the fracture provided they are loosened or can be lifted out without undue trauma (Fig. 7). Lacerations of the oral mucous membrane are packed open with iodoform gauze. External lacerations, however, will produce less scarring, if sutured primarily leaving ample provision for drainage. Depending on the type of injury and external contamination of the wound, the advisability of administering tetanus antitoxin must be given consideration.

The method of immobilization to be utilized in a case of fracture of the jaw is dependent on several factors: the site of the break and its duration, whether single or multiple, the presence or absence

of teeth in the fragments, and whether there has been loss of bone. The simplest and at the same time the most universally satisfactory method of immobilizing fractures of the jaws when teeth are present in the fragments is by wiring the upper and lower teeth together (Fig. 8). The teeth in the fractured jaw are thus brought into normal occlusion and the fragments thereby held in correct alignment. As a rule the application of 10 per cent cocaine solution locally is the only anesthesia required for this procedure. When there is marked displacement of the fragments or the fracture has existed for a considerable time a general anesthetic or blocking the second and third



Fig. 10. Spontaneous fracture in the median line of the mandible following electrocoagulation of estrovera epithelioma of the lower lip and chin. Satisfactory immobilization of fractures of this type can, as a rule, be secured by means of a Barton or four tail bandage.



Fig. 11. Drawing of roentgenogram of vertical fracture through the horizontal ramus posterior to the last molar tooth. The edentulous fragment will, as a rule, engage with the end of the anterior fragment and satisfactory immobilization can be secured with intermaxillary wiring.

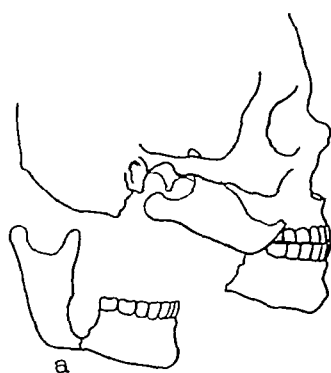


Fig 12

Fig 12 Drawing of roentgenogram of usual displacement of edentulous fragment in cases in which loss of bone is considerable. The posterior fragment is drawn anteriorly and upward against the under surface of the malar bone. At the same time marked lateral and posterior displacement of the anterior fragment occurs. Insert *a* illustrates fracture and extent of loss of bone, in this instance the fracture occurred following the removal of an impacted molar tooth.

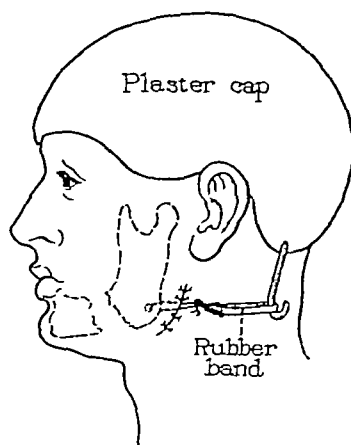


Fig 13

Fig 13 The method used by Ivy and Curtis for correcting displacement of edentulous posterior fragment.



Fig 14

Fig 14 Gunning vulcanite splint for the immobilization of fractures of edentulous jaws. This must be supplemented with a snug head bandage to prevent separation of the jaws. Silver wires passed through the upper alveolar process of the splint and entirely around the mandible are also required in some cases.

divisions of the fifth nerve on one or both sides may be necessary. The latter procedure is usually preferable since with the teeth wired together the vomiting reaction from a general anæsthetic induces a real hazard (Fig 9). The time necessary to keep the teeth wired together varies in different cases depending on whether the fracture has been seen immediately or several weeks after its occurrence. The age and general condition of the patient, the severity of the inflammatory reaction present in the soft tissues, and the presence of osteomyelitis or osteitis at the site of fracture are likewise factors in this regard. From 3 to 4 weeks in children to approximately 6 weeks in healthy

adults is the usual time unless there is considerable local infection. Under favorable circumstances firm healing of mandibular fractures will often take place in patients of advanced years in less than 6 weeks.

The various head bandages, including the Barton and the four-tail, are of little value in the fixation of mandibular fractures, except in supplementing other measures. They should not be used alone except in median line fractures without displacement as they exert posterior as well as upward pressure and they accordingly tend to

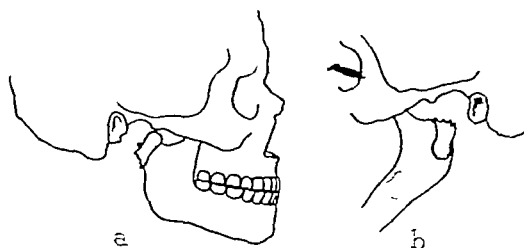
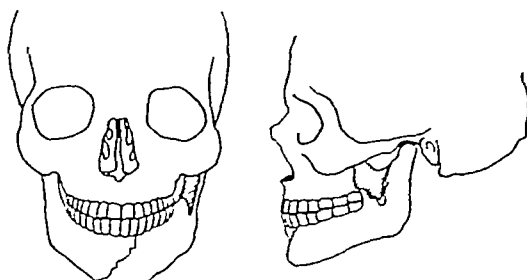


Fig 15 Drawings of roentgenograms of fractures of the condyle. *a*, Fracture of this type in a girl aged 16 years. Although no attempt was made to replace the condyle in the glenoid cavity the result was excellent, both from a cosmetic and functional standpoint. The mandible was immobilized for 5 weeks by wiring the upper and lower teeth together. *b*, Fracture of condyle of a boy aged 8 years.



Treatment consisted of immobilization of the mandible for a period of 3 weeks. Although the functional result was good the jaw was displaced slightly to the side of the fracture on opening the mouth widely.

Fig 16 Drawing of roentgenogram of fracture of left coronoid process and across the symphysis of the mandible resulting from a blow on the chin of a man aged 72 years.

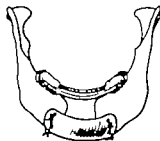


Fig. 17. Bone graft for fracture of mandible with considerable loss of bone. Graft is held in place by means of chronic catgut ligatures. The dental appliances for immobilizing the fragments may be noted.

produce overriding of the fragments with increased deformity (Fig. 10).

Fractures of the mandible in which no teeth remain in the posterior fragment are often difficult to immobilize on account of the tendency for the muscles of mastication to displace the edentulous fragment. When the plane of the fracture is approximately vertical the edentulous fragment will often impinge on the posterior end of the anterior fragment (Fig. 11). If the fracture extends downward and posteriorly through the angle or transversely across the ascending ramus, or if there is appreciable loss of bone the posterior fragment will as a rule slip forward and be drawn upward into the mouth (Fig. 12). Reduction and immobilization of such a fracture often requires considerable ingenuity. One of numerous dental appliances designed to make pressure against the posterior fragment inside the mouth may be used,



Fig. 8, left. Loss of posterior two-thirds of the right mandible and paralysis of the right seventh nerve, the result of maling accident. Displacement of lower jaw on opening mouth may be noted.

Fig. Following the use of bone graft (compare 17th Figure 7) The displacement of the lower jaw on opening the mouth has been overcome.

a nail may be driven through the coronoid process or the procedure recently described by Ivy and Curtis (3) may be resorted to (Fig. 13).

Fractures of edentulous jaws are best treated with vulcanite intermaxillary splints. Such splints consist of a double bite block into which the upper and lower alveolar processes fit snugly (Fig. 14). Fractures of the jaws do not lend themselves well to fixation with metal plates on account of the proximity of the infected oral cavity and the stress placed on them. Little is likely to be accomplished by attempting their use either in



Fig. 9, left. Retouched roentgenogram which shows the loss of the posterior portion of the right mandible in case illustrated in Figure 8.

Fig. 10. Roentgenogram following use of bone graft from the iliac crest. Same case as shown in Figures 8 and 19. It may be noted that the superior end of this is articulated in the glenoid cavity.

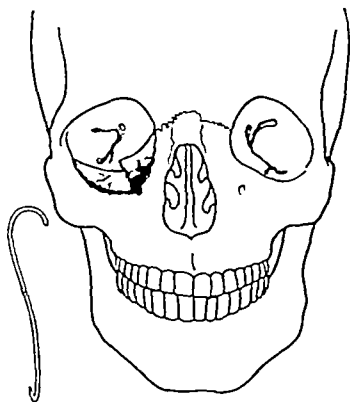


Fig 22 Drawing of roentgenogram of fracture of the lower orbital border with displacement posteriorly. Such fractures usually extend into the infra-orbital foramen and canal resulting in injury to the infra-orbital nerve. The malar bone also is commonly involved and accompanying this there frequently is displacement inferiorly of the orbital floor resulting in diplopia. Insert shows steel wire hook used in elevating fractures of this type.

this group or in the preceding groups of cases. They should never be used until complete healing of the wounds in the soft tissues has taken place.

Fractures of the condyle are best demonstrated in roentgenograms of the mastoid area and in those taken in the so called Towne position, that is obliquely from above and anteriorly with the patient lying on his back. Such fractures have at times been subjected to open operation. The results have not been very satisfactory because of the difficulty of maintaining alignment. Also the operation involves considerable hazard as regards the possibility of injury to the facial nerve. A number of such patients treated in The Mayo Clinic by fixation with interdental wiring has obtained excellent results even when marked displacement of the condyle was present (Fig 15). In no instance was any attempt made at replacement of the condyle in the glenoid fossa, yet a normally functioning jaw with little, if any, displacement or deformity resulted. Scudder, on the contrary, stated that fractures of the condyles generally result in ankylosis.

Fractures of the coronoid process are unusual. When unaccompanied by fracture of other portions of the mandible immobilization for a week or two only is required (Fig 16).

Repair of fractures of the jaw is always greatly delayed with loss of an appreciable amount of bone. Non-union is the rule and bone graft after complete healing of the wound is required. While healing is taking place fixation of the fragments is



Fig 23, left. Traumatic scarring and depressed fracture of the inferior orbital border and malar bone, due to an automobile accident $3\frac{1}{2}$ months previously.

Fig 24. Result following excision of scars and insertion of cartilage implant to restore the orbital border and malar prominence.

secured by means of one of the mechanical appliances mentioned, or preferably, if a sufficient number of teeth is present, by interdental wiring. If the wound in the mouth is permitted to heal without such fixation, the fragments will be drawn together by the scarring and marked deformity will result. It then becomes necessary to free the scarring sufficiently to permit of restoring the fragments to their normal position where they are held firmly until healing is complete, when a bone graft may be inserted.

Non-union of fractures of the mandible may be due to loss of bone, unsatisfactory immobilization, improper apposition of the fragments, osteomyelitis, syphilis, or the presence of a dental root or sequestrum in the line of fracture. Treatment depends on the cause of non-union. When due to loss of bone, it is invariably permanent without the use of a bone graft. Non-union due to any of the other causes will, in most cases, be overcome and firm union will take place on directing proper treatment to the causative factors. Dental structures or sequestrum in or adjacent to the fracture are commonly responsible for lack of union. Even though the condition is of several months standing removal of the offending objects will usually be followed by prompt healing. Osteomyelitis aside from free drainage should be treated conservatively. Syphilis may be a factor in this condition, in which event antisyphilitic measures should be instituted. In a case of non-union encountered recently syphilis was present, and a metal plate used in a futile attempt to immobilize the fragments was acting as a foreign body. The secondary pyogenic infection persisted until the plate



Fig. 5. Drawing made from roentgenogram of comminuted fracture of the superior maxilla of a girl, aged 8 years, the result of an automobile accident. The anterior portion of the superior alveolar process and bony palate was displaced upward about 1/2 inch situated posteriorly just above the tuberosity. In addition, the fracture extended upward, involving a large portion of the face and involving the cribriform plate. Dental caps with elastic bands utilized in drawing the upper alveolar down into occlusion after the patient had recovered from the immediate effects of the shock fracture are shown. Drawing of roentgenogram of fracture, a, of superior maxilla the result of an accident. The patient, boy aged 5 years, ran into a clothesline with his mouth open. The line engaged behind the upper anterior teeth and the fracture occurred on the rebound, resulting in downward displacement of the posterior portion of the alveolar process together with most of the remainder of the superior maxilla about 1/2 inch situated high up anteriorly. Treatment consisted of wiring the upper and lower teeth together and applying snug head bandage. An excellent result was obtained.

was removed, in spite of treatment for the syphilis. Non-union due to unsatisfactory immobilization demands further mechanical consideration. Fixation may be extremely difficult, if not impossible, if patients do not co-operate.

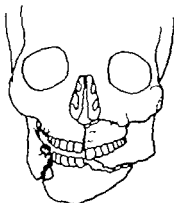


Fig. 6. Drawing of roentgenogram of multiple fractures of the upper and lower jaws, and dislocation anteriorly of the one condyle, the result of an automobile accident. This patient came under observation a week after the injury and there was marked infection and acute inflammatory reaction present, necessitating delay of 1 week longer in manipulation and immobilize the fragments.

In cases of persistent non-union, bone grafting is indicated. Prior to undertaking this it is essential that the wound inside the mouth as well as that externally should be completely healed, and that any teeth near the ends of the fragments should be extracted, and that ample time should be given for the sockets to become obliterated. Some means must also be arranged to insure firm fixation of the fragments (Fig. 17). Any of the various types of bone transplants may be utilized. A massive bone graft from the crest of the ilium is,



Fig. 7. Roentgenogram following immobilization of fractures (Fig. 6). A single metal arch was wired to the teeth in the normal remnant of the superior alveolar process and the remaining fragments were then drawn into position by wiring to this. The two upper molars back are driven into the alveoli were removed. Open reduction of the dislocated condyle was necessary.

as a rule, most satisfactory. Grafts may also be obtained from a rib or the tibia, or bone from the lower border of one fragment of jaw may be slid across to bridge the defect. The graft is introduced through an external incision below the border of the mandible. Following this the jaw should be fixed for at least 2 months, depending on the roentgenographic appearance of the graft (Figs 18, 19, 20, and 21).

Malunion of fracture of the jaw sufficiently pronounced to require surgical treatment is unusual. Serious consideration should be given the possibility of correcting the deformity and the interference with function due to it by prosthesis or otherwise before resorting to refracture, because of the possibility of infection and of non-union.

Fractures of the upper jaw are usually the result of crushing blows to the face. Automobile accidents account for a high proportion of such injuries. They are often more difficult to reduce and immobilize satisfactorily than are mandibular fractures, and permanent facial deformities commonly result. Such deformities are by no means an indication of lack of skillful treatment at the time of injury in all of these cases. Many such injuries are extremely serious, a high percentage being accompanied by fracture of the skull, so that manipulation of the bony fragments is often not advisable during the first 2 weeks. By the end of that time sufficient fibrous union will often have taken place greatly to increase the difficulty of properly aligning the fragments, if not to render this quite impossible without excessive trauma. Correction of the deformity can, therefore, be carried out more satisfactorily after complete healing has taken place.

When fractures are limited to the superior maxilla they most commonly involve the alveolar process and the inferior orbital border. Fractures of the alveolus may be limited to a small portion of the process bearing one or several teeth. They may, on the other hand, involve the entire alveolus on one or both sides, so that this, together with the corresponding portion of the bony palate is completely mobilized, being supported only by the soft tissues attached to it. The teeth or any portion of the alveolus may be driven upward and impacted within the antrum or the nasal fossa.

In fractures of the lower orbital border the bony ridge is usually forced posteriorly into the orbit or inferiorly into the antrum (Fig 22). Injury to the infra-orbital nerve with anæsthesia of the area supplied by it is usually present in these cases. Depression or flattening of the upper portion of the cheek also results, especially in those cases with fracture of the malar bone as well. Edema

usually conceals the deformity of the cheek for a considerable time following the injury, and palpation and roentgenographic examination alone will reveal the change. When recognized within a few days after the injury, depressed fractures of the orbital border can usually be elevated readily. This may be accomplished by grasping the depressed bone with a heavy towel clamp directly through the skin and manipulating it into position. (2) The screwdriver may be used for the purpose as suggested by Ivy and Curtis. (4) A periosteal or septal elevator inserted through a small incision lateral to the outer orbital margin may be used as a pry or a metal sound introduced into the antrum through a naso-antral window as suggested by Shea may be employed particularly in those cases with depressed fracture of the anterior wall of the antrum. A heavy metal probe carried through the canine fossa may accomplish the same objective (Lothrop). A rigid steel wire hook introduced through a small incision over the fracture has proved satisfactory in most of the cases treated in The Mayo Clinic (Fig 22). The hook is carried posteriorly onto the floor of the orbit just far enough to permit its sharp edge to engage the overhanging bony edge of the orbital border. With traction on the hook the depressed bone is then drawn up into its normal position. At times there is a distinct clicking or snapping sound as the bone buckles out into normal alignment and only moderate traction is required. More frequently no sound is heard and considerable force must be exerted. Usually there is no tendency for the deformity to recur. At times, however, the bone sags back immediately on releasing the pull and it is necessary to maintain this for several days. For the purpose a properly shaped stiff wire arch is utilized, this being strapped to the face in such a manner that its looped ends rest on the bone at a considerable distance from the fracture. The hook supporting the fracture is fastened to this rigid arch. When the presence of such a fracture is not recognized for 2 or 3 weeks following the injury, so much fibrosis will usually have developed that elevation of the fracture as described is extremely difficult or quite impossible, and it is better to wait until complete healing has taken place and then insert a bone or cartilage implant for correction of the deformity. Costal cartilage serves the purpose most satisfactorily. The implant is shaped according to a model prepared from dental compound. Sufficient perichondrium is left on its anterior surface to permit it to be sutured in place (Figs 23, 24).

Fractures involving only a portion of the superior alveolar process may be immobilized satis-

factorily by wiring the upper and lower teeth together when one or more teeth remain in the normal remnant of the superior alveolus. If teeth are present at both sides of the fracture a dental appliance can be used to advantage. Fractures in which there is complete separation of the alveolar process and hard palate from their bony attachment above may likewise be fixed by intermaxillary wiring in some cases, but this must be supplemented by a snug bandage in order to prevent movement of the mandible. When there is comminution of the maxilla above the palate, in such cases fixation from the skull is necessary. This requires the application of a plaster of Paris skull cap in which are incorporated two adjustable metal arms for the support of a dental appliance. Non-union of such fractures may occur and a difficult problem is then presented, since the thinness of the bone and the inaccessibility to surgical approach through a sterile field greatly lessen the chances of successfully transplanting bone. In fractures of the upper jaw accompanied by fracture of the cribriform plate or of the base of the skull further posteriorly the patient may be in such precarious condition that any manipulation is inadvisable for at least a week or two following injury. There may be in addition upward displacement and impaction of the parts (Fig. 25).

Multiple fractures of the upper and lower jaw in which there is mobilization of both entire alveo-

lar processes are at times encountered. Fixation in such a case often necessitates the use of a dental appliance consisting of a double bite block rigidly supported by adjustable metal arms attached to a plaster of Paris skull cap. Even a small portion of the superior alveolar process remaining intact in such a case is of great help in securing immobilization, as it supplies a fixed point that otherwise must be furnished by mechanical means. At times in a case of the latter type satisfactory fixation can be secured by the use of a single rigid metal arch. This is wired to the teeth in the normal superior alveolar remnant, and the teeth in the several fragments are drawn into occlusion by wiring to it (Figs. 26 and 27).

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VAGINAL VERSUS RECTAL EXAMINATIONS IN RELATION TO OBSTETRICAL MORBIDITY FOLLOWING THE MERCUROCHROME TECHNIQUE

AN ANALYSIS OF 3,884 CASES AT THE METHODIST EPISCOPAL HOSPITAL IN BROOKLYN, NEW YORK¹

H W MAYES, A M , M D , F A C S , NEW YORK

From the Obstetrical Department of the Methodist Episcopal Hospital Brooklyn, New York

SINCE obstetrics has become recognized as a science, many efforts have been made to reduce maternal morbidity and mortality. Reis and Kronig in 1893 recommended the use of rectal examinations. There have been many arguments for and against this procedure, and, today, rectal examinations are not universally accepted as the proper method in following the course of labor. They were first introduced in order that the prevalence of puerperal sepsis might be lowered, but, after almost 30 years, there seems to be no decrease in this disease. If we have lowered the number of deaths from sepsis by rectal examination, we have introduced some other factor which has acted as a counterbalance.

Fourteen years ago Moore stated that "Rectal examination alone, or when combined with abdominal palpation in pregnancy and labor, as a substitute for vaginal examination during parturition, is not compatible with an intelligent management of childbirth." He advised a primary vaginal examination in all cases first seen in labor, and of course, where any operative interference is indicated.

De Lee states that "one can overdo rectal exploration. It is not needful to make many as the progress can be measured by abdominal examinations and intelligent observation of the processes of nature. Too many rectals may injure the delicate mucosa and rough manipulations should be avoided. The thin edematous septum may possibly be punctured."

When the patient complains that the rectum is sore, Campbell believes that there is no question about there having been too many rectal examinations. Thrombosis may be encouraged in an external hæmorrhoid, which otherwise might escape. A rectal examination is never pleasant, and it is doubly distasteful at a time when, through instinct, the patient would rather not be disturbed. He mentions the case of a patient operated on for ischiorectal abscess, who dated her trouble from a confinement 6 months previous. "With a history of protrusion or bleeding following stool, whether from hæmorrhoids or prolapsed mucous membrane, rectal examinations should be as few as

possible. If there is pain or sphincteric spasm, they are contra-indicated except for diagnosis of a rectal condition. There is a physiological magnification of rectal pathology during pregnancy. The rectal tissues share to a certain extent in the congestion and softening incident to pregnancy, and obstruction from the weight of the gravid uterus increases any tendency to varicosity of the hæmorrhoidal veins. Bleeding indicates a break in the mucous membrane and a little added trauma may force bacteria below the surface at this point. A low grade infection may be set up which will cause the hæmorrhoidal condition to become so progressive as to require operation at a future time."

Parke stated that the tyro learns nothing from rectal examinations, and it is difficult to convince the beginner that it is worth while to practice the method often enough to acquire confidence in his findings, for a large experience is required to learn the finer points. He believes that in 90 per cent or more of the cases, one can get all the information that is needed in the conduct of labor.

Coldren, writing from the standpoint of the student, states that it is not easy to feel things in the vagina with a finger in the bowel. He states that the student struggles through his course of instruction pretty much in the dark about the parturient vagina, but as soon as he gets out into practice, away from the watchful eye of the instructor, he begins to feel the need of knowing something about the patient beyond the fact that she seems to be pregnant, and he proceeds to learn his obstetrics at first hand, as occasion demands.

The medical schools have been teaching the use of rectal examinations for many years. The course offered in obstetrics is very meager, and the opportunities are few for the students to learn the art of rectal examination. When we realize how difficult it is for even an experienced obstetrician to be convinced of his rectal findings, that an error of 10 per cent is generally admitted (and with the inexperienced it must be higher), how can we expect the neophyte to make no serious mistakes. Five thousand medical students are licensed every year, and it is required of them that

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factorily by wiring the upper and lower teeth together when one or more teeth remain in the normal remnant of the superior alveolus. If teeth are present at both sides of the fracture a dental appliance can be used to advantage. Fractures in which there is complete separation of the alveolar process and hard palate from their bony attachment above may likewise be fixed by intermaxillary wiring in some cases, but this must be supplemented by a snug bandage in order to prevent movement of the mandible. When there is comminution of the maxilla above the palate, in such cases fixation from the skull is necessary. This requires the application of a plaster-of-Paris skull cap in which are incorporated two adjustable metal arms for the support of a dental appliance. Non-union of such fractures may occur and a difficult problem is then presented, since the thinness of the bone and the inaccessibility to surgical approach through a sterile field greatly lessen the chances of successfully transplanting bone. In fractures of the upper jaw accompanied by fracture of the cribriform plate or of the base of the skull further posteriorly the patient may be in such precarious condition that any manipulation is inadvisable for at least a week or two following injury. There may be in addition upward displacement and impaction of the parts (Fig. 25).

Multiple fractures of the upper and lower jaw in which there is mobilization of both entire alveo-

lar processes are at times encountered. Fixation in such a case often necessitates the use of a dental appliance consisting of a double bite block rigidly supported by adjustable metal arms attached to a plaster-of-Paris skull cap. Even a small portion of the superior alveolar process remaining intact in such a case is of great help in securing immobilization, as it supplies a fixed point that otherwise must be furnished by mechanical means. At times in a case of the latter type satisfactory fixation can be secured by the use of a single rigid metal arch. This is wired to the teeth in the normal superior alveolar remnant, and the teeth in the several fragments are drawn into occlusion by wiring to it (Figs. 26 and 27).

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TABLE II—RECTAL AND VAGINAL EXAMINATIONS, PRIVATE CASES
Exclusive of Cesarean Sections—1929-1930

	Spontaneous			Operative			Total cases		
	Cases	Morbidity	Per cent morbidity	Cases	Morbidity	Per cent morbidity	Cases	Morbidity	Per cent morbidity
Rectals only	622	28	4.5	614	36	5.8	1236	64	5.1
Rectals plus one vaginal	84	3	3.5	161	7	4.3	245	10	4.4
Rectals plus two or more vaginals	28	3	10.7	79	6	7.5	107	9	8.4
Vaginals only	78	2	2.5	101	8	7.9	179	10	5.5
Vaginals plus one rectal	40	4	10.0	59	2	3.3	99	6	6.06
Vaginals plus two or more rectals	83	3	3.6	159	8	5.03	242	11	4.5
No examination	39	4	10.2	10	1	10.0	49	5	10.2
Total	974	47	4.8	1183	68	5.7	2157	115	5.3

second stage of labor. One may not find out his mistake until untoward signs on the part of the mother and child demand interference.

The literature was carefully reviewed by La Vake in 1928, and he found very few comparative statistics concerning rectal and vaginal examinations. Among the most important contributors were

Jegge who compared 500 cases examined vaginally with 500 examined rectally. The morbidity of the former was 11 per cent, and of the latter, 6 per cent.

Guggsberg reported 4,642 cases examined vaginally, with a morbidity of 17.5 per cent, 11.2 per cent of which developed genital infection, and 0.12 per cent died from sepsis, while 3,010 cases examined rectally showed only 11 per cent morbidity, 5.5 per cent of which showed genital infections, and there were no deaths from sepsis.

Reis stated that of 609 patients examined vaginally, 47 per cent were afebrile, of 271 examined rectally, 46 per cent were afebrile, while of 106 not examined at all internally, 57 per cent were afebrile. He concludes "If then, as most workers agree, the rectal examination is only 90 per cent efficient for diagnosis, and if it is especially inadequate for abnormal and pathological cases, it would seem that at least one vaginal examination is desirable early in every case of labor."

The rapidity and ease with which the rectal examination can be made recommends it strongly, but it does not seem that rectal examination should replace the vaginal examination in a well conducted maternity hospital where vaginal examination can be made under aseptic precautions.

Dean, in 1925, stated that rectal examinations were used by a very small minority of the profession in following the progress of labor. He stated

that in placenta prævia or unusual bleeding cases, in obese primiparæ, and in cases with an abnormal presentation, when it was difficult or impossible to reach the cervix, a vaginal examination should be made, although he favored the use of rectal examinations.

Welz says "Rectal examinations are objectionable because they are not always accurate, they increase the danger of infection, and may result in injury to the rectum."

In previous articles I have endeavored to study the effect of vaginal antisepsis on cesarean sections, bag inductions, and maternal morbidity and mortality. The following is the result of a study carried on at the Methodist Episcopal Hospital during the 2 years, 1929 and 1930.

In this hospital, we have two services: the first is in charge of Dr. O. P. Humpstone, the second is in charge of Dr. R. M. Beach. Beginning January 1, 1928, we endeavored to make it the routine practice for the second service that the ward patients should be examined only vaginally, and for the first service, only by rectum. If we could have made the rule inviolable, the results would have been much better. When a patient was admitted in active labor, it was often important to examine her before she was prepared. Therefore, on the second service, we permitted the internes to make a single rectal examination in these cases, but after the patient was prepared and instilled, only vaginal examinations were in order. On the first service there were to be no vaginal examinations, but needless to say, there were times when a vaginal examination was indicated. This upset the routine, and it is, therefore, difficult to draw proper conclusions. Almost every case with a prolonged labor, or any other abnormality, as to the presentation, position, etc., had a vaginal examination. Thus it is easy to see that every case

TABLE L.—RECTAL AND VAGINAL EXAMINATIONS, WARD CASES
Exclusive of Cesarean Sections—1929-1930

	Specimens			Operative			Total cases		
	Cases	Morbidity	Per cent morbidity	Cases	Morbidity	Per cent morbidity	Cases	Morbidity	Per cent morbidity
Rectals only	245	17	7	156	8	4.8	401	25	9
Rectals plus one vaginal	64		3	73	9	3	137	12	8.8
Rectals plus two or more vaginals	9	1	2	8		5	17	1	5.8
Vaginals only	209		7	297	9	3.4	506	16	3.4
Vaginals plus one rectal	200	14	7	96	4	4.5	296	18	6
Vaginals plus two or more rectals	4		8	17	5	28.8	21	5	23.8
No examinations	2	3	150	8		75	60	4	6.6
Total	520	75	14.4	467	26	5.6	987	40	4.1

they deliver a certain number of obstetrical patients. Some medical colleges insist that they spend 1 year in a hospital with maternity service. Thus, it is reasonable to make the assertion that before a man is sure of his rectal findings, he must follow at least one hundred patients through labor. If this is true, when we consider how our hospitals are manned almost entirely by internes (many of whom are not interested in and will not practice obstetrics) and realize that they are entrusted with the lives and offspring of our best citizens, it behooves us to reduce the number of their mistakes to a minimum.

Patients enter our best maternity hospitals, take the best rooms, pay for one or two private nurses to care for them, and often their entire labor is under the supervision of an inexperienced interne who follows the course of labor by means of rectal examinations. He is really a student, learning the art of rectal examinations. Then when the patient is about ready for delivery or perhaps after she has labored all night, with an unrecognized disproportion, or a concealed second stage of labor, the attending obstetrician appears on the scene, and proceeds to complete, perhaps, a long delayed delivery.

If students do only rectal examinations, it is difficult for them to interpret their findings. However, if each rectal examination were immediately checked by someone of experience, or if it were followed immediately by a vaginal examination, we might conceive of an excuse for this practice without endangering the life of the unborn child. How many mistakes are made annually and the number of infants who are lost because of a prolapsed cord or because of a concealed second stage of labor will never be known.

I often wonder if there is really any difference between the use of vaginal and rectal examina-

tions as far as infection is concerned. During the rectal examination, the posterior vaginal wall is forced into the cervix and many times this belongs to the lower third of the vagina, which is not considered sterile. Rectal examinations are usually cervical examinations while during vaginal examinations it is only necessary to outline the cervix. When the rectal examination is completed, the pelvic floor is contaminated, unsterile gloves are frequently used, the doctor is prone to be careless, the thumb may enter the vagina, and the doctor even though experienced in rectal examinations, is often left in doubt. The glove the posterior vaginal wall, which may be edematous, and the high position of the presenting part, may render it difficult or impossible to make a satisfactory examination.

Before making a vaginal examination, the patients are usually more carefully prepared, and the perineum is kept cleaner during labor. The patient is more pleased with the examination, and the satisfaction of knowing and not guessing the condition of the cervix etc. is of no little moment.

When the rectal examinations were first introduced, vaginal antiseptics was not used. Today it is practically possible to sterilize the vagina, and repeated vaginal examinations can be done with little, if any added risk to the mother. Our students and internes can be taught more and better obstetrics, and is it not possible that maternal and fetal mortality and morbidity may be reduced?

La Vake believed that the greatest potential danger resident in rectal examination is overlooking what has been called "the concealed second stage of labor." The patient may be allowed to continue in labor without a vaginal check being made, because the physician believes that she is in the first stage of labor when she is really in the

TABLE IV—RECTAL AND VAGINAL EXAMINATIONS, CÆSAREAN SECTIONS
With and Without Morbidity—1929-1930

	Without morbidity	With morbidity	Total	Per cent morbidity
Rectals only	21	24	45	53.3
Rectals plus one vaginal	4	3	7	42.8
Rectals plus two or more vaginals	4	2	6	33.3
Vaginals only	4	8	12	66.6
Vaginals plus one rectal	4	5	9	55.5
Vaginals plus two or more rectals	7	5	12	41.6
No examination	24	21	45	46.6
Total	68	68	136	49.6

1,680 were operative, with a morbidity of 6.3 per cent. One thousand nine hundred and forty-seven were followed by rectal examinations only, with a morbidity of 5.08 per cent. One thousand two hundred and thirty-three cases had both vaginal and rectal examinations with a morbidity of 6.08 per cent. Ten thousand eight hundred and thirty-two rectal examinations were made on 3,180 cases, or an average of 3.4 to the patient. Five hundred and ninety-five cases were followed by vaginal examinations alone, with a morbidity of 6.8 per cent. There were 390 additional cases which were followed by vaginal examinations but had a single rectal examination on admission, making a total of 985 with a morbidity of 6.5 per cent. One thousand eight hundred and twenty-eight had at least one vaginal examination with a morbidity of 6.3 per cent. This gives a morbidity for the cases followed by vaginal examinations of 1.3 per cent greater than those followed by rectal examinations only. There were 4,811 vaginal examinations among 1,818 patients, or an average of 2.6 to the patient. We must realize that the rectal group does not include the more difficult cases. Two thousand four hundred and eighty cases were followed by rectal examinations, with a morbidity of 5.3 per cent, 533 of which had at least one vaginal examination. There were 109 cases not examined during labor, with a morbidity of 8.2 per cent.

Table IV analyzes the morbidity of 136 cases following cesarean section, with a morbidity of 49.6 per cent, 45 of which were followed by rectal examinations with a morbidity of 53.3 per cent. There were 58 cases which had at least one rectal examination with a morbidity of 50 per cent. Forty-six cases had at least one vaginal examination with a morbidity of 50 per cent. Forty-five cases were not examined during labor, with a morbidity of 46.6 per cent. This group includes the majority of cases of elective cesarean sections, without a test of labor.

Maternal mortality There were no maternal deaths from sepsis in the 3,884 viable vaginal deliveries, and only one death from sepsis in 136 cesarean sections. This patient had ruptured membranes for 5 days before operation.

Personal cases There were 238 of 281 personal private cases which had at least one vaginal examination, with a morbidity of 14 or 4.9 per cent. Thirty-six patients had only rectal examinations, with a morbidity of 4.7 per cent, and seven were not examined and were without morbidity.

SUMMARY

A review of the literature emphasizes the inaccuracy of rectal examinations.

Rectal examinations, although accepted as a routine procedure in a large number of hospitals, are not universally accepted (indeed they are sometimes condemned).

Many mistakes are undoubtedly made by those who are learning the art of rectal examinations, while a 10 per cent error is admitted for those of experience.

Vaginal examinations are much more satisfactory to both the patient and the physician, and the satisfaction of knowing, and not guessing, the condition of the cervix is of great value.

Rectal examinations may injure the recto-vaginal septum and aggravate pathological conditions, such as, hemorrhoids, fissures, etc.

Following viable vaginal deliveries, 3,884 cases had an uncorrected morbidity of 5.7 per cent. The difference between the operative and the spontaneous morbidity was 1 per cent.

A comparative study of the ward and private cases showed 1 per cent less morbidity for the private cases, while the cases followed by rectal examinations had less morbidity only on the ward services.

In 1,947 cases with only rectal examinations there was a morbidity of 5.08 per cent, and in

TABLE III.—RECTAL AND VAGINAL EXAMINATIONS, TOTAL CASES
Exclusive of Cesarean Sections—1929-30

	Spontaneous			Operative			Total cases		
	Cases	Morbidity	Per cent morbidity	Cases	Morbidity	Per cent morbidity	Cases	Morbidity	Per cent morbidity
Rectals only	167	11	4.7	790	44	5.6	957	55	5.6
Rectals plus one vaginal	148	8	5.3	34	16	4.8	182	24	5.4
Rectals plus two or more vaginals	47	4	8.5	106	8	7.6	153	12	7.9
Vaginals only	307	14	6	108	17	8	415	31	6.3
Vaginals plus one rectal	140	15	7.5	30	6	6	170	21	6
Vaginals plus two or more rectals	114	3	3	106	11	6.9	220	14	5.8
No examination	91	7	7.6	13	17	17	104	24	5
Total	1001	71.8	7.3	1180	108	6	2181	104	5.7

with a difficult delivery or prolonged labor is classed under those cases having vaginal examinations.

A vaginal examination should be very little more than the procedure of instillation with mercurochrome. The barrel of the syringe is as large as the two fingers and it could carry the bacterial flora to the cervix. Thus we might say that every patient had the equivalent to a vaginal examination.

We have considered only those examinations done before the time of delivery. When the patients are prepared and ready for delivery, we make no effort to keep out of the vagina. Many cases had vaginal examinations at this time. Many were forceps cases. In many episiotomies were indicated or lacerations ensued. The perineum is very often ironed out manually. These factors offer many opportunities for transfer of bacteria from the lower to the upper part of the vagina.

ANALYSIS OF MORBIDITY

The uncorrected morbidity on the first obstetrical service for the 2 years was 6.9 per cent, and on the second, 7.3 per cent. If we omit the cesarean sections, the morbidity was 5.1 per cent for the first obstetrical service, and 6.5 per cent for the second, while the corrected morbidity was 3.4 per cent for the first and 2.8 per cent for the second. The following tables analyze the morbidity not according to service but according to the method by which the labor was followed, either by rectal or vaginal examinations. Any case in which the patient had a temperature of 100.4 degrees F on two consecutive days, not including the day of delivery, and occurring on or before the tenth day is considered a morbidity.

Table I shows the comparative morbidity for the spontaneous and operative cases following the

use of rectal and vaginal examinations on the ward service. There were delivered 1717 cases with a morbidity of 6.3 per cent, 1,130 of these were spontaneous, with a morbidity of 5.7 per cent, and 497 were operative with a morbidity of 7.6 per cent. It is rather interesting to note that there was but 0.1 per cent difference between the operative and spontaneous cases which had rectal examinations only while 300 cases which were followed by vaginal examinations and had only one rectal, had a morbidity of 7 per cent for the spontaneous, and 4.3 per cent for the operative. The question might be asked "Why did the operative have less morbidity than the spontaneous?" Rectal examinations were made in 540 cases with one or more vaginals and the morbidity was 7.1 per cent, while 950 cases had at least one vaginal examination with a morbidity of 7.3 per cent. Sixty cases were delivered without being examined during labor with a resulting morbidity of 6.6 per cent.

In Table II, 1,157 private cases with a morbidity of 5.3 per cent have been analyzed. The operative morbidity is but 0.9 per cent greater than the spontaneous, while the majority of the cases 1,136 were followed by rectal examinations with a morbidity of 5.1 per cent. Six hundred and ninety three additional cases had at least one rectal examination and one or more vaginal examinations with the same morbidity, 5.1 per cent. The added vaginal examinations did not increase the morbidity. At least one vaginal examination was made in 871 cases with a morbidity of 4.6 or 5.2 per cent. Forty cases in this table had no examination whatever with a morbidity of 10.2 per cent.

Table III combines the ward and private patients and analyzes 2,181 cases with a morbidity of 5.7 per cent. Of the 2,181 cases, 1,001 were spontaneous with a morbidity of 5.3 per cent, and

MORTALITY FACTORS IN GYNECOLOGY

A STATISTICAL STUDY OF THE DEATHS FROM 1902 TO 1932 AT THE FREE HOSPITAL FOR WOMEN, BROOKLINE

MARSHALL K. BARTLETT, M.D., AND FRED A. SIMMONS, JR., A.B., BROOKLINE, MASSACHUSETTS

A REVIEW of the current literature reveals a relative lack of discussion of mortality factors as seen in a gynecological clinic. In the last 30 years 17,695 patients have been treated at the Free Hospital for Women, making a relatively large group suffering from gynecopathic disorders. The majority of patients at this clinic present conditions which require surgical intervention, and our attention is focused, therefore, mainly on the postoperative mortality. Figures are also presented on non-operative deaths and terminal cancer deaths. The latter group represents a fairly large proportion of the total deaths, since the hospital has a special ward devoted to the care of these patients.

From January 1, 1902, to January 1, 1932, 262 deaths occurred, divided for our purposes into 95 cases of terminal malignancy, 19 cases not operated upon, and 148 cases the result of operative complications. Seventeen of these patients, 6.5 per cent, came to autopsy. In the remaining cases the statistics are based on clinical diagnosis.

Of the 95 cases of terminal malignancy, 19 had never been treated surgically, 63 had had surgical treatment, but the interval between operation and death was of sufficient length to justify the elimination of surgical intervention as a contributory factor. In the remaining 13 cases, death occurred within 1 month of operation. Nine of these had had exploratory laparotomy for inoperable malignancy, the 4 others had had palliative curettage and cauterization for extensive carcinoma of the cervix. Although we do not believe that operation was a definite factor in these fatalities, it is necessary to consider that death may have been hastened by operative measures.

In the next group of 19 non-operative deaths, the causes were distributed as shown in Table I.

TABLE I—NON-OPERATIVE DEATHS

Influenza (epidemic 1918)	0
Pelvic cellulitis	4
Pyelonephritis	2
Miscellaneous (intestinal obstruction urinary suppression obstructive jaundice, generalized peritonitis)	4
Total	10

The patient having intestinal obstruction was admitted in a moribund condition 1 week after the

onset of symptoms. The case with peritonitis showed, at autopsy, inoperable cancer of the rectum with perforation.

OPERATIVE MORTALITY

During the 30-year period studied, 16,820 operations were performed. There were 148 deaths directly attributable to the operation or postoperative complications, a gross mortality of 0.96 per cent. For purposes of comparison we cite the following figures from other clinics: gynecological or general. Norris, in 1920, published a study of a series of 4,212 gynecological operations with 24 deaths, a mortality of 0.57 per cent. Peterson presented a series of 1,734 operative cases with a 0.58 per cent mortality, or 16 deaths. Polak and Tallefson recorded a series of 3,125 operations with 95 fatalities, or a mortality of 2.0 per cent.

Harris says that in contrast to the appalling surgical (and medical) mortality of the eighteenth century, today mortality from elective operations is almost negligible, ranging from 0.5 to 1.5 per cent. Loria presented statistics covering a period of 7 months of gynecological treatment at the Charity Hospital in 1928 and 1929, showing 31 deaths from 2,025 admissions, a mortality of 1.53 per cent. His figures for all surgical deaths in a general hospital were 317 deaths in 5,050 admissions, or a 6.26 per cent mortality.

In our study it seemed desirable to classify the surgical procedures roughly as to their extent and as to the anæsthetic agent employed (Table II).

TABLE II—EXTENT OF OPERATION AND ANÆSTHESIA

Type of operation	Anæsthesia					No anæsthesia	Total
	Ether	Spi nal	Gas oxy gen	No- vo- cain	Av er tin		
Plastic	5,340	5	34	2	0	145	5,526
Laparotomy	3,338	5	5	0	0	0	3,357
Double	6,087	13	0	0	1	0	7,001
Breast operations	507	0	1	2	0	7	517
Examination	101	0	5	0	0	0	106
Miscellaneous	265	8	6	27	0	16	322
Totals	16,538	31	51	40	1	168	16,820

3,180 cases that had at least one rectal examination the morbidity was 5.4 per cent.

Ten thousand eight hundred and thirty-two rectal examinations were done on 3,180 patients, or an average of 3.4 to the patient.

In 595 cases in which only vaginal examinations were made the morbidity was 6.8 per cent while in 985 cases, 380 of which had had a single rectal examination before being prepared, the morbidity was 6.5 per cent.

One thousand eight hundred and twenty-eight cases had 4,811 vaginal examinations or an average of 2.6 to the patient, with a morbidity of 6.3 per cent.

In 109 cases in which no examinations were made during labor the morbidity was 8.2 per cent.

In the cesarean group there was less morbidity following vaginal than rectal examinations.

In 238 personal cases in which at least one vaginal examination was made the morbidity was 4.9 per cent and in 36 patients with only rectal examinations the morbidity was 4.7 per cent.

The slight increase (about 1 per cent) in the morbidity in all the vaginal groups can be accounted for by the fact that vaginal examinations were done on all the more difficult cases and on those with prolonged labors.

	Cases	Morbidity	Per cent morbidity
Total deliveries 1933 to Oct. 1938	9541	67	7.04
Cesarean sections	385	60	49
Deliveries less cesarean	9156	907	5.4
Corrected morbidity 1930 to Oct. 1938	5371	47	7

From January 1, 1930 to October 1, 1938 there were 4 deaths following the vaginal delivery of viable child, two of these were due to hemorrhage, one of which had ruptured uterus; one died from eclampsia and the other from liver necrosis. There were 87 cesarean sections with 3 maternal deaths.

CONCLUSIONS

The use of mercurochrome as a vaginal antiseptic during labor and at the time of delivery makes vaginal examinations a safe procedure.

The prevailing high stillbirth rate may be due in part to the fact that abnormal conditions are not recognized in time by rectal examinations.

Every patient should have at least one vaginal examination early in the course of her labor and if labor is not normal, it should be repeatedly checked by a vaginal examination.

NOTE.—Up to the present time we have had 9,316 viable vaginal deliveries following the present mercurochrome technique, with but a single death from puerperal sepsis.

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deaths, a mortality of 18 per cent Graves (5) described 1,399 personal cases with 22 deaths, a mortality of 1.57 per cent Burch and Burch, in a protest against the statements that mortality from hysterectomy was low, gave statistics on 166 operations for supravaginal hysterectomy with a mortality of 4.2 per cent

TABLE III—SUPRAVAGINAL HYSTERECTOMY

Classification	No of deaths	Total	Deaths	Per cent
		1005	16	1.6
Fibroids (and leiomyosarcoma)				
Causes of death				
Under ether	6			
Nervous—adynamic	2			
dynamic	1			
Peritonitis	2			
Pulmonary embolus	1			
Operative shock	1			
Acute nephritis	1			
Myocardial failure	1			
Purpura hæmorrhagica	1			
	16			
Pelvic inflammatory disease (including tuberculous)		829	11	1.3
Causes of death				
Peritonitis	4			
Operative shock	3			
Typhoid fever	1			
Under ether	1			
Intestinal obstruction	1			
Pneumonia	1			
	11			
Prolapse and procidentia		406	11	2.7
Causes of death				
Pulmonary embolus	4			
Myocardial failure	3			
Pneumonia	2			
Operative shock	1			
Sepsis (? source)	1			
	11			
Endometriosis (and adenomyoma)		84	1	1.2
Causes of death				
Pneumonia	1			
Benign ovarian cysts		118	2	1.7
Causes of death				
Urinary suppression	1			
Exhaustion	1			
	2			
Malignant ovarian cysts		48	4	8.3
Causes of death				
Under ether	2			
Myocardial failure	1			
Operative shock	1			
	4			
Superfluous uterus*		55	1	1.8
Causes of death				
Pneumonia	1			
Extra-uterine pregnancy		19	1	5.3
Causes of death				
Myocardial failure	1			
	1			
Functional uterine bleeding		110	0	0
Carcinoma of cervix		6	0	0
Carcinoma of endometrium		12	0	0
Carcinoma of tube		3	0	0
Bicornuate uterus		7	0	0
Epilepsy		7	0	0
Hæmatometra		1	0	0
Sterilization		1	0	0
Cirroid aneurism		1	0	0
Hæmatoma of broad ligament		1	0	0
Total supravaginal hysterectomies		2733	47	1.7

*Under 'superfluous uterus' are included those cases in which the pelvic organs have passed their period of active function and are so definitely the focus of symptoms although they are not diseased, that their removal seems justified

Muller reported 2,991 cases of supravaginal hysterectomy for *fibroids*, with 146 deaths or a mortality of 4.9 per cent Graves (5) reported 754 cases, with 6 deaths, a mortality of 0.79 per cent

Complete hysterectomy Table IV shows the operative mortality and causes of death in 329 patients who had complete hysterectomy performed for various conditions, including cancer This series as a whole shows a mortality of 7.9 per cent attributable to operation Complete hysterectomy was performed in 229 cases at the Mayo Clinic in 1926 with 3 deaths, a mortality of 1.3 per cent (Masson 12) Graves (6) published statistics, on a series of 119 cases of complete hysterectomy for carcinoma of the cervix performed by Pemberton and himself with 6 deaths, or an immediate mortality of 5 per cent He also cited figures of Cobb, who reported a mortality of 5 per cent in 30 cases Burch and Burch report a 3.1 per cent mortality in 32 cases of complete hysterectomy

TABLE IV—COMPLETE HYSTERECTOMY

Classification	No of deaths	Total	Deaths	Per cent
		120	10	8.3
Carcinoma of cervix				
Causes of death				
Operative shock	4			
Pneumonia	2			
Pulmonary embolus	1			
Myocardial failure	1			
Urinary suppression	1			
Under ether	1			
	10			
Carcinoma of endometrium		72	8	11.1
Causes of death				
Peritonitis	3			
Pulmonary embolus	2			
Pneumonia	1			
Myocardial failure	1			
Coronary embolus	1			
	8			
Fibroids (and leiomyosarcoma)		50	4	8.0
Causes of death				
Operative shock	2			
Peritonitis	1			
Pulmonary embolus	1			
	4			
Pelvic inflammatory disease		50	1	2.0
Causes of death				
Pneumonia	1			
Functional uterine bleeding		11	1	9.1
Causes of death				
Pulmonary embolus	1			
Vesicovaginal fistula		1	1	100.0
Causes of death				
Under ether	1			
Endometriosis (and adenomyoma)		5	0	0
Prolapse and procidentia		6	0	0
Superfluous uterus		5	0	0
Malignant ovarian cysts		4	0	0
Benign ovarian cysts		3	0	0
Pyometra		1	0	0
Chorio-epithelioma		1	0	0
Total complete hysterectomies		329	25	7.9

Repair of postoperative ventral hernia It is interesting that in this group of 284 cases, all subjected to long and extensive operative procedures, the mortality was only 1.1 per cent, with 3 deaths

In the classification in Table II the operations included under the various headings are defined as follows:

Plastic. This group comprises all procedures performed in the lithotomy position, ranging from simple dilatation and curettage to complete reconstruction of the pelvic outlet. Hemorrhoidectomy has also been included in this group.

Laparotomy. This group includes all cases in which the peritoneal cavity was opened through the anterior abdominal wall.

Double refers to those cases in which the two above operations were performed at the same time.

Breast operations. Include resection, simple amputation and radical amputation. Ten in which radium treatments were given for recurrence of malignant disease are also included. In 6 of these cases of recurring malignant disease the treatment was given without anesthesia. In the 4 others ether was used.

Examination means bimanual pelvic examination under an anesthetic.

Miscellaneous includes all operations not falling into the preceding classifications. Though mostly minor in type, various major procedures are included e.g. 131 kidney operations.

GROSS OPERATIVE MORTALITY

The operative mortality of plastic operations was 0.22 per cent in a series of 5,526 cases.

The operative mortality of laparotomy operations was 59 in a series of 3,357 cases, or 1.2 per cent.

For the double operation group there were 65 deaths in 7,001 cases, or an operative mortality of 0.93 per cent. The higher mortality in the laparotomy group is accounted for by the fact that many of the cases of cancer fall into this classification.

NoRis gives a series of 5,439 vaginal cases (plastic) with 8 deaths (0.32 per cent) while his abdominal (laparotomy) cases show a mortality of 0.89 per cent with 12 deaths in 1,345 operations, and the combined (double) operations, 428 in number show 4 deaths, or a mortality of 0.93 per cent. Peterson divides his 1,754 cases into 527 major operations and 1,226 plastics, with 70 deaths in the plastic series.

SPECIFIC OPERATIVE MORTALITY

Here we present tables showing the incidence of death from operations for a specific pathological condition, to illustrate the prevailing causes of death resulting from that particular operation as occurring in our series.

PLASTIC OPERATIONS

Complete perineorrhaphy. Repair of complete laceration of the perineum was done on 270 patients. There were three deaths, an operative mortality of 1.1 per cent. Uremia, peritonitis, and pneumonia accounted for one death each.

Curettage and coagulation for carcinoma of the cervix. This operation was performed before the advent of radium as a palliative procedure in advanced cancer of the cervix in 121 cases. There were 2 deaths, both due to operative shock. The mortality is thus 1.7 per cent.

Vulvectomy. Complete vulvectomy was done on 29 patients. In 4 of these dissection of the groins was also carried out. Partial vulvectomy was performed in 8 cases. There were no deaths in this group.

Vaginal hysterectomy. This operation has been performed only 3 times in the last 30 years in this hospital. There was no operative mortality.

Other vaginal operations. In this group are included all plastic operations not already specifically classified. Operation was performed on 5,090 patients. There were 7 deaths, an operative mortality of 0.14 per cent. Cerebral hemorrhage and operative shock accounted for 1 death each. Peritonitis accounted for the 5 remaining fatalities. In all of these cases a septic process was present in the pelvis at the time of operation. Two patients had vaginal drainage of pelvic abscesses. One had an infected ovarian cyst with twisted pedicle, which was drained by vagina, in 1907. Another patient had pelvic cellulitis following an attempted abortion and was delivered of a macerated fetus. The fifth patient had a dilatation and evacuation of a small pyometra. Autopsy on the next day showed a large carcinoma of the sigmoid with generalized peritonitis.

If we exclude these 5 cases and thus obtain statistics for the "clean" vaginal operations, the mortality becomes 0.04 per cent.

It should be noted that this group includes the vaginal application of radium to 1,274 cases. Of these 1,162 operations were performed under ether and 112 without anesthesia. There were no deaths in this group of radium treatments.

LAPAROTOMY AND DOUBLE OPERATIONS

Supravaginal hysterectomy. There were 573 operations for supravaginal hysterectomy with a mortality of 47 cases or a percentage of 17 (Table III).

Mason stated that the mortality from either supravaginal or complete hysterectomy should not exceed 2 per cent, and cited 217 subtotal hysterectomies at the Mayo Clinic in 1926 with 4

CAUSES OF DEATH

Classified by causes, the 148 deaths in this series fall into the groups shown in Table VII. The percentage of the total number of deaths represented by each group is also given, together with the average age of the patients.

TABLE VII—CAUSES OF DEATH

	Deaths	Per cent	Age (years)
Peritonitis	34	22.9	37.5
Shock	22	14.9	49.0
Pulmonary embolus	21	14.2	52.4
Under ether	18	12.3	41.1
Pneumonia	16	10.8	44.3
Myocardial failure	12	7.4	55.0
Renal complications	8	5.4	43.3
Miscellaneous	8	5.4	55.5
Acute myocarditis and coronary embolus	4	2.7	46.5
Intestinal obstruction	3	2.0	48.0
Cerebral accident	3	2.0	55.3

Peritonitis The greatest single cause of death is thus peritonitis, occurring in 34 cases and accounting for 22.9 per cent of the deaths. The average age of these patients was 37.5 years. Of these deaths 14 followed laparotomy. Thus death from peritonitis occurred in 0.42 per cent of the 3,357 laparotomies done. In 3 of these cases acute peritoneal infection was present at the time of operation. Deducting these to get a corrected figure for "clean" cases we get 0.33 per cent mortality. Four of these cases had chronic pelvic inflammation at the time of operation.

Eleven deaths occurred after double operations, 0.16 per cent of the 7,001 done. One of these patients had peritonitis at operation, the corrected figure becoming 0.14 per cent.

Six deaths from peritonitis followed plastic operations, of which there were 5,526, a mortality of 0.11 per cent. Five of these 6 cases had an acute septic process in the pelvis at operation, giving a corrected figure for "clean" cases of 0.018 per cent.

Of 12 operations for suprapubic cystotomy, 2 patients died, a mortality of 16.7 per cent. In 1 of these the transperitoneal route was used.

One patient in the group of 132 kidney operations died of peritonitis, a mortality of 0.76 per cent. Nephrectomy for tuberculosis of the kidney and ureter was performed in this case.

Operative shock Twenty-two patients died from this cause, 14.9 per cent of the total. The average age in this group was 49.0 years.

Ten of these deaths, or 45.5 per cent, followed operations for malignancy. Complete hysterectomy for carcinoma of the cervix was performed upon 4 of them. In one of these cases operated upon in 1902 it was necessary to resect the bladder and implant both ureters in the vagina. Two patients died of operative shock after curettage and cauterization for extensive cervical cancer.

Following exploratory celiotomy for advanced abdominal malignancy, 2 deaths occurred. One patient died following supravaginal hysterectomy for bilateral malignant ovarian cysts with metastases in the abdominal wall. Another patient died following palliative simple mastectomy for advanced carcinoma of the breast with metastases to ribs and mediastinum.

Operations for fibroids accounted for 5 deaths from shock, or 22.7 per cent of the deaths in this group. Supravaginal hysterectomy accounted for 2 of these deaths and complete hysterectomy and myomectomy for 1 death each. The fifth patient was moribund on admission. Enucleation of a sloughing fibroid and delivery of a macerated fetus was performed *per vaginam*.

Supravaginal hysterectomy for pelvic inflammatory disease resulted in death from operative shock in 3 cases. This constitutes 13.6 per cent of this group.

The 4 remaining deaths followed supravaginal hysterectomy for prolapse, nephrectomy for hydronephrosis, excision of retroperitoneal dermoid cyst, and excision of retroperitoneal fibroma.

Pulmonary embolus This complication was the cause of death in 21 cases, 14.2 per cent of the total. The average age of this group, 52.4 years, corresponds with the findings of Badgley and Smith, who state that patients past 50 years of age are prone to pulmonary embolism. The average postoperative interval was 9.0 days. An abdominal operation had been performed in all cases. Hysterectomy, either complete or supravaginal, was done in 10 of the 21 cases in this group.

In 4 cases the operation was done for cancer. One patient had a complete hysterectomy for postmenopausal bleeding at the age of 65, although no malignancy was found. This occurred previous to the use of radium in the treatment of these cases.

The underlying pathology was leiomyomata in 2 cases and in 1 patient the operation was performed for repair of a postoperative ventral hernia.

The remaining 13 patients, or 61.9 per cent of all cases in this group, died of pulmonary embolism following operations for prolapse and procidentia. It is disturbing to find such a large proportion of fatal pulmonary emboli occurring in patients subjected to what are essentially operations of election.

Under ether Deaths occurring under ether, on the operating table, accounted for 18, or 12.3 per cent of the total fatalities. The average age of these patients was 41.1 years, somewhat under the

TABLE V.—REPAIR OF POSTOPERATIVE VENTRAL HERNIA

Classification	No. of deaths	% of operations	Deaths Per cent
Postoperative wound hernia			
Covered at death			
Malpositioned abdominal			
Under other			
Pulmonary embolism			
	3		

Gall-bladder operations. One hundred and thirty patients underwent operation for gall-bladder disease. Cholecystectomy was performed in 88 cases and cholecystostomy in 41. The common duct was drained in relatively few cases in this series. There was 1 death in this group an operative mortality of 0.77 per cent. Death was due to subdiaphragmatic abscess and duodenal fistula, 3 weeks following choledochostomy Harris discussed 1113 operations reported by Judd and Walters at the Mayo Clinic in 1929. Of these 771 were cholecystectomies with a mortality of 1.4 per cent. Another report of 984 cases gave a death rate of 2.9 per cent.

Other abdominal operations. Into this group fall all abdominal operations which are not classified in the specific groups reviewed above, e.g. myomectomy appendectomy salpingectomy oophorectomy suspension of uterus, etc. We appreciate that this represents a heterogeneous group of cases, but it does not seem desirable to subdivide them further. In many of the cases a plastic operation was combined with the abdominal procedure. There were 47 operative deaths in 6,868 operations, or a mortality of 0.68 per cent. Nine of the deaths were in patients who had either inoperable abdominal malignancy (6) or generalized peritonitis (3) at the time of operation. Excluding these deaths the mortality for this group becomes 0.51 per cent. By far the largest subdivision of this group of other abdominal operations is that of suspension of the uterus, approximately three thousand of these cases consisting of Oshagen's operation. Graves and Smith (8) gave an elaborate table of 3,358 cases from 1890 to 1928, which includes many of the same patients discussed in our paper. They tabulated 15 deaths attributable to operative procedure for suspension of the uterus, a mortality of 0.45 per cent. This figure corresponds so closely to our corrected figure of 0.51 per cent that it serves to illustrate the persistent mortality from so-called minor abdominal cases. There seems to be a fairly constant mortality from gynecological laparotomy for minor causes of about one-half of one per cent.

TABLE VI.—OTHER ABDOMINAL OPERATIONS

Classification	No. of deaths	Total cases	Deaths Per cent
All other abdominal operations			
Cases of death:			
Pulmonary embolism	13		
Pulmonary infection	11		
Peritonitis	10		
Cerebral shock	3		
Under other	1		
Subdiaphragmatic abscess			
Acute myocarditis			
Cerebral hemorrhage			
Cerebral aneurysm			
Wound rupture			

GENITO-URINARY OPERATIONS

Fifty-five nephrectomies were performed, with 2 deaths 1 attributed to peritonitis and the other to operative shock, a mortality of 3.6 per cent. Nephrotomy was done on 21 patients. There were 2 deaths, an operative mortality of 9.5 per cent. One patient died of acute urinary suppression and the other of intestinal hemorrhage of unknown origin.

In 43 cases nephropexy was done. There were no deaths in this group.

Ureterotomy was done in 10 cases without operative mortality.

Decapsulation of the kidney was performed on 3 occasions. Two of the patients died a mortality of 66.7 per cent. One of these deaths was due to acute toxic nephritis due to iodine poisoning, for the relief of which the operation was undertaken. In the other case pyelonephritis was found at operation and decapsulation of the kidney was done.

Suprapubic cystotomy was carried out on 12 patients. There were 2 deaths, a mortality of 16.7 per cent. Both deaths were due to peritonitis. In one of these cases a transperitoneal approach was employed.

BREAST OPERATIONS

Radical mastectomy with removal of both pectoral muscles and axillary dissection, was performed in 212 cases with two deaths, a mortality of 0.94 per cent. One death was due to cerebral hemorrhage. The other occurred suddenly following one of a series of intravenous treatments with colloidal lead for carcinoma. It was considered that death was due to either pulmonary embolism or some allergic phenomenon. There is some question whether or not this should be considered an operative death.

Following simple mastectomy there were two deaths out of 113 cases, a mortality of 1.8 per cent. One was due to diabetic coma and occurred previous to the introduction of insulin. The other resulted from surgical shock following a palliative operation for advanced carcinoma.

16 out of 16,538, or 0.096 per cent. All but one of the 16 patients had had an abdominal operation. The one remaining case came following repair of a complete laceration of the perineum.

Graves (7), reporting on 2,000 consecutive cases without a death at the Free Hospital for Women in 1910 (which cases are included in our study), said, "The absence of mortality in the Free Hospital cases confirms Risley's observation that postoperative pneumonia or bronchitis in clean cases is of shorter duration and of less serious nature than in septic cases, the majority of the Free Hospital cases being clean cases." He further quoted Homans' series of 3,280 gynecological cases with 257 deaths (7.83 per cent), 50 of these deaths being due to lung complications, or 1.53 per cent.

While not a gynecological report, the excellent paper of Cutler and Hunt, in 1920, on "Post-operative Pulmonary Complications" affords an interesting comparison of statistics from a general surgical clinic, with its necessarily septic cases, with figures from a comparatively "clean" series. They reported 8 deaths from pneumonia in 1,562 cases, or 0.51 per cent. Their study of statistics from 9 other papers in addition to their own series gives one a bird's eye view of 41,368 operations with a death percentage from pneumonia of 0.41. It would appear that the low figure at the Free Hospital for Women might also be attributed to the fact that our patients receive 2 or 3 days of treatment before operation, consisting of rest and bowel management, surely a large factor in improving any patient's operative risk.

Cardiac complications. In 11 cases, 7.4 per cent of the total fatalities, death was attributed to acute myocardial failure with cardiac dilatation. The average age in this group was 55.0 years. Here, as in fatal pulmonary emboli, we find double operations for prolapse and procidentia accounting for a large proportion of the deaths, in this instance 6 of 11 fatalities. Only one of these 6 patients had any definite findings on physical examination to indicate cardiac disease. This case showed a blood pressure of 234-130, even after a considerable period of rest in bed.

One patient with carcinoma of the cervix had a rheumatic heart lesion without history of decompensation. She died of acute myocardial failure following complete hysterectomy.

There were 4 additional cardiac deaths. Two were due to acute endocarditis, 18 days and 1 month after operation. One of these patients had a definite pre-existing rheumatic lesion. There was no clinical evidence of one in the other case.

In one patient death was attributed to coronary embolism and in another to acute myocarditis.

Renal complications. Eight patients died of renal complications. Their average age was 43.3 years. They represent 5.4 per cent of the total deaths. In 4 cases death was due to urinary suppression, to acute nephritis in 2 patients, and to uræmia and pyelonephritis in 1 case each.

The urinary suppression was mechanical in nature in 1 of the 4 cases mentioned, both ureters having been ligated in the course of a difficult hysterectomy.

In 132 kidney operations, there were 3 deaths due to renal complications, a percentage of 2.3. In 2 of these the factor causing death was present at the time of operation, being pyelonephritis in 1 case and acute toxic nephritis following iodine poisoning in the other.

There were 4 deaths due to renal complications out of 3,357, a mortality of 0.15 per cent from this cause. Out of 5,526 plastic operations done 1 patient died of uræmia, giving 0.018 per cent. This patient gave a history of "Bright's disease" and showed a trace of albumin in her urine before operation.

Intestinal obstruction. There have been 3 post-operative deaths due to intestinal obstruction in the past 30 years. All 3 patients had laparotomies and all had supravaginal hysterectomy for fibroids. In 1 case the obstruction was paralytic in type, while in the 2 others it was dynamic. Both of the latter had secondary exploratory laparotomy performed for relief of the obstruction.

Cerebral accident. Three patients died following cerebral accidents. Two were definite cerebral hæmorrhages in elderly patients, 1 following a plastic for procidentia and 1 after radical mastectomy for cancer. The third patient was a young single woman aged 30 years, who had a double operation for pelvic inflammatory disease. She died 12 hours after operation in convulsions, with extreme cyanosis. This was interpreted as some sort of cerebral accident.

Miscellaneous. Eight patients died of miscellaneous causes, constituting 5.4 per cent of the total fatalities.

One patient died of subdiaphragmatic abscess and duodenal fistula 3 weeks after choledochostomy. Another patient died of hyperpyrexia of unknown origin, 2 months following a two-stage double operation for procidentia. It was felt that she probably had some obscure focus of sepsis, but exploratory coeliotomy failed to reveal the nature of the process.

A diabetic patient with carcinoma of the breast died in coma 8 days after simple mastectomy.

average of the group as a whole. The average length of operation in the 15 cases in which data are available was 68 minutes.

All patients dying under ether had abdominal operations. Hysterectomy was performed in 11 of the 18 cases. It was done for fibroids in 6 cases, for malignant ovarian cysts in 2 cases, and in 1 patient each for carcinoma of the cervix, pelvic inflammation, and vesicovaginal fistula.

Double reconstructive operations for prolapse accounted for 3 deaths under ether. Repair of ventral hernia, oophorectomy for malignant cyst, and exploratory celiotomy for intestinal obstruction accounted for the 3 remaining deaths.

Of the 18 patients, 4 were definitely poor operative risks. One case, with a malignant ovarian cyst, was 78 years of age and had a blood pressure of 180-90 with a history of a preceding cerebral accident. One patient with pelvic inflammatory disease had a bad rheumatic heart lesion. Another patient had carcinoma of the cervix, had lost 20 pounds in 2 months and her general condition made her a poor risk. The fourth patient had intestinal obstruction 6 days after supravaginal hysterectomy for pelvic inflammation and was in poor condition at the time of the second operation.

The 14 remaining patients were satisfactory operative risks, in so far as could be determined. It is fairly generally conceded by authorities on anesthesia that deaths occurring under ether in patients who are in good physical condition must be attributed to the anesthetic agent. There is considerable variation of opinion as to the frequency of such deaths under ether. Cushny gives 1 death for every 10,000 cases as a good general average. Kaye states that death from ether in certain public general hospitals is as high as 1:3 per cent. During the period studied, ether was administered 16,538 times with 14 fatalities; an incidence of 1 case in 1,181 or .085 per cent. Since all the deaths under ether occurred during abdominal operations, it is interesting to note that considering this group alone we find 14 deaths in 10,335 operations, an incidence of 0.15 per cent. It is perhaps remarkable that anesthesia accidents are not more frequent in this hospital, as the ether is given in most cases by medical students, although under the careful supervision of a competent anesthetist.

Cushny states that in the majority of the accidents occurring under ether overdosage is the cause. He further states that experimental work has shown that in deaths of this type the heart always continues to function after respirations have ceased. How long the heart will continue to

function depends on how much cardiac damage has occurred before respirations cease. This in turn depends on the concentration of the ether vapor that the patient has been inhaling; the more concentrated the vapor the more extensive is the cardiac damage. When very concentrated vapor is used the interval is inappreciable and the pulse may be so weak as to be imperceptible to the anesthetist before respirations cease.

Kaye, in an exhaustive study of anesthetic deaths coming to autopsy reported 22 deaths under ether during 1919 to 1929. He stated that the manner of death was primary circulatory failure in 7 cases and primary respiratory failure in nine. In 2 cases failure of pulse and respiration seemed synchronous and in 4 patients the point could not be decided. At autopsy cardiac failure apparently describes all but one of his series, about which he commented that there was no organic lesion. His conclusions from a study of 107 deaths under anesthesia were that every general anesthesia involves a small but definite risk, of the order of perhaps 1:3 per 1,000." He does not state whether or not the head was examined.

We are also reminded by Sollman that patients died on the operating table before anesthesia was used. He says "In pre-anesthetic days the French surgeon Desault drew his fingernail over the perineum of a patient to mark the line of incision, when the patient gave a cry and was dead."

Cushny and Sollman agree that autopsies in cases of acute ether death show nothing beyond the usual phenomena of asphyxia. Merritt reports 4 cases in detail. Three of the deaths are attributed to "bleeding into the tissues, corresponding to the so-called 'shock'." The fourth case was due to fat embolism. In the first 3 cases the patients had a bright red color when death occurred due to peripheral vasodilatation. He concludes, therefore, that color cannot be taken by itself as an indication of the well-being of the patient.

Autopsies were done on 2 of our cases. One of them was entirely negative. The head was not examined in this case. The second case showed a marked cerebral edema and was otherwise negative.

Pneumonia. The seasonal incidence is the outstanding feature of the group of 16 patients who died of postoperative pneumonia. Fourteen, or 87.5 per cent, of them died during the October to April period, while only 2 died in the May to September interval.

The gross mortality due to pneumonia in patients who received ether was very low being

EDITORIALS

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THE CLINICAL PATHOLOGICAL CONFERENCE

THE importance of holding clinical pathological conferences is almost universally recognized. Not so commonly emphasized is the importance of suitably staging such conferences, in order that the utmost benefit under the least distressing circumstances may be achieved. That the morgue or the pathological laboratory are usually poorly adapted places and that the chosen room should be comfortable, well lighted, and well ventilated may be stated without argument. Other features, however, may merit more careful consideration.

Often one of the weakest points in the meeting is the method or manner of presentation of the clinical history. To watch an interne or a staff physician thumb over a voluminous collection of clinical notes and then listen to him attempting to read all sorts of findings, most of them irrelevant and immaterial, is not only time consuming, but it is likely to "kill" the meeting almost before it starts. The strictly essential data about any patient may be presented in a very

few words. Better yet a lantern slide may be made, containing every clinical fact which is necessary to note concerning the case under discussion. This procedure has the advantage of focusing the attention of the audience on the single case, and the various details of that patient's story may be supplemented by comments or questions.

The proper presentation of the gross specimens is another element in the success of the conference. The passing around on a dirty plate or tray of a wet specimen which reeks with formalin, which is handled at one's peril, and which shows very poorly the lesion it is supposed to represent, certainly becomes a severe test of the fortitude and enthusiasm of those who are in attendance. With only a little more diligence the pathological specimen obtained at necropsy or operation may be trimmed intelligently and so sectioned or dissected as to reveal the diseased area to the best advantage. It may then be fixed in any of the various modifications of Kaiserling's fluid for the purpose of partially restoring its original color values. Immediately before the meeting the specimens may be removed from the jars, excess fluid wiped off and the surfaces painted with a warm 15 per cent solution of gelatin, put on with a soft camel's hair brush. With this gelatin film the specimens will not dry so quickly, they retain their colors and sheen, and can be easily handled without soiling the hands or contacting them with offensive odors. Instead of being passed around they may be placed on clean, neat trays arranged on tables high enough so that too much stooping will be avoided, and each specimen may be identified as to organ

under ether anesthesia. This occurred previous to the introduction of insulin.

Another patient died suddenly after an intra venous injection of colloidal lead for cancer. This happened 13 days following radical mastectomy. Death was attributed either to pulmonary embolism or some allergic reaction.

Two patients died of intestinal hemorrhages. One of them had thrombocytopenic purpura. The etiology of the bleeding could not be determined in the other case.

A 74 year old woman failed gradually and died of "exhaustion" 7 weeks after supravaginal hysterectomy for large bilateral benign ovarian cysts. No specific cause of death could be found in this case.

Another patient, 65 years of age, had an exploratory laparotomy with evacuation of ascitic fluid and cyst contents for inoperable malignant cystadenoma of the ovary. Two weeks later she developed a total right hemiplegia with loss of speech. Five days later she had recovered her power of speech and a large degree of muscular control, when her wound ruptured throughout its entire length. The wound was resutured under novocain anesthesia, but nevertheless, the patient died a few hours later.

SUMMARY AND CONCLUSIONS

1. The 262 deaths occurring during the past 30 years at the Free Hospital for Women have been studied. They have been divided into 95 cases of terminal malignancy, 148 postoperative deaths, and 19 cases not operated upon.
2. Autopsy was performed on 65 per cent of the cases.
3. The terminal malignancy and non-operative groups have been briefly analyzed.
4. The gross operative mortality for all operations performed was 0.96 per cent. Comparative statistics have been cited.
5. The various operations have been classified roughly by degree of difficulty and the mortality for each group has been computed.
6. The mortality from plastic operations was 0.22 per cent for 5,570 cases. In 5,357 laparotomy cases the mortality was 1.2 per cent, and in 7,001 double operations it was 0.93 per cent.
7. The causes of death following various operations for specific pathological conditions have been given in detail, and the outstanding causes have been discussed.

8. The operative deaths have been divided into groups according to cause of death. Each group has been studied and a summary of the analysis given.

9. Special attention has been given to cases dying under ether during operation.

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individual differentials are present in most tissue, and are common to a given species. Similarly the tissues of near relatives of different strain, varieties, species genera, and classes of animals have in common certain chemical characteristics. The tissues of the host assume injurious properties, and toxins are thrown out which destroy the grafts. These differentials determine the degree of intensity of reaction between host and donor.

Experimental work has shown that the substances thrown off by the graft do not act, as a rule, in the nature of antigens and do not call forth the production of secondary (immune) substances on the part of the host which cause the graft to be destroyed. If secondary (immune) reactions were important it might be expected that the homo-reaction following a second transplantation would appear more promptly but no acceleration of time seems to occur. The evidence seems to indicate that individual differentials in homo-transplantation are shown by primary substances given off by the grafts which act as toxins and stimulate the cells of the host to a leucocytic and fibroblastic cellular reaction against the graft.

The hypothesis that these differentials are genetically determined is suggested by the whole series of gradations in reactions found on transplanting tissues into strange hosts. The individual differentials are more closely related within the same family, species, or strain. Consequently, grafts of skin from brother to brother or sister to brother (close syngenesio-transplantation) remain viable the longest after transplantation. A slight decrease in the length of time that the graft remains viable is noted in the case of transplantation of parent to child (a more distant type of syngenesio-transplantation). Experiments in close inbred animals also show similar varying reactions according to the nearness or

distance in relationship of the donor and the host. Thus, we conclude that organismal differentials are genetically determined.

Apparently the organismal differentials depend upon the totality of genes which make up the chromosomes which are present in the cells of the host and donor. Presumably the genes or more specifically gene derivatives determine the character of the differentials. The Y chromosomes must have little to do with reaction as it makes little difference whether host or donor are of same sex.

According to the theoretical considerations previously outlined, the improbability that the blood group of the donor and host can be of particular significance is evident. Blood groups probably depend upon a few genes and tend to throw all individuals into approximately four groups, while individuality differential is most likely determined by all or at least a great number of the genes of an individual. Thus, if the theory of organismal differentials holds, it multiplies the possibilities of the strangeness of the tissue of the donor to the recipient to an infinite number.

At the present time, the evidence—both experimental and clinical—is sufficient to justify the following brief conclusions: (a) Autotransplantation of skin usually succeeds. (b) Syngenesio-transplantation of skin is theoretically improbable except in identical twins where it is theoretically probable and clinically has occurred. (c) The failure of experimental isodermic grafts on the human and on animals to remain viable and theoretical reasoning argue against the blood group of the individual as playing a rôle of any essential significance in homotransplantation of skin. (d) And finally, the bulk of experimental and clinical experience is in agreement that iso- or homotransplantation of skin is not practicable except possibly in identical twins.

EARL C. PADGETT

and lesion by an appropriate label in close proximity. Then the audience may be invited at any time before, during or after the meeting to inspect these specimens, well lighted and well displayed. During the presentation of the pathological features of the case additional but not essential refinement may be effected by showing lantern slides which depict by photography the gross appearances of the disease process. This photography may add a rather important feature as the camera can magnify the picture, thus revealing the finer details which might be lost to the unaided eye. The photograph also becomes a part of the permanent record.

No conference is complete unless the microscopic features are presented. This may be best accomplished through a microprojection lantern, but stained sections under microscopes may serve as a substitute. The advantage afforded by the lantern is the opportunity for demonstration and discussion.

Lastly the spirit pervading the conference must be marked by enthusiasm for the truth, forbearance toward the mistakes of others, and frankness in acknowledging one's own errors. Brevity, clearness, attractive presentation of specimens, considerate regard for the other fellow and the earnest endeavor to draw helpful conclusions will make a clinical pathological conference one of the most valuable meetings which any physician can attend.

H. E. ROXBOROUGH

IS SKIN GRAFTING WITH ISOGRAFTS OR HOMOGRAFTS PRACTICABLE?

SOMETIMES quite competent surgeons pander to the wondering delight of a credulous laity and mother brother and even friends are encouraged to give up a part of their skin to some poor injured soul.

But unkind fate as yet seems to have decreed that such a sacrificial offering on the altar of a sympathetic and generous martyrdom is doomed to failure for both experimental and practical evidence indicate that isodermic skin grafting is not practicable except possibly from identical twin to identical twin.

Recently the great importance of the relative nearness of the relationship between the host and the transplant as the principal factor that determines the fate of the graft has been recognized in its full significance. Loeb¹ found that in skin transplantation from animal to animal, the length of time the graft remains viable depends upon the amount of leucocytic and fibroblastic reaction shown by the host against the graft and the intensity of the reaction depends upon the nearness of the blood relationship of the donor to the recipient. More recently in the human Loeb's findings have been substantiated by a series of experimental skin transplants (forty four in number) performed by Padgett.²

Briefly the result to be expected after isodermic skin transplantation may be summarized as follows. An immediate "take" occurs in the majority of cases. In non-related individuals, between the second and third week, the grafts begin to disappear and by the end of the fourth week have completely disappeared. Individuals related by blood (syngenesio-transplantation) such as father to son or even uncle to nephew the graft "takes" and remains viable about three weeks but by the end of the fifth week it is destroyed. In identical twin transplantations (the closest possible syngenesio- or near relation transplantation) the grafts have remained in situ in 4 cases over 1 year and it is assumed such grafts may take permanently.

Most likely certain chemical characteristics, which were designated by Loeb as the

¹Physiol. Rev. 1926, 2, 247.
²Arch. M. J., 1926, 277, 566-590.

individual differentials are present in most tissue, and are common to a given species. Similarly the tissues of near relatives of different strain, varieties, species genera, and classes of animals have in common certain chemical characteristics. The tissues of the host assume injurious properties, and toxins are thrown out which destroy the grafts. These differentials determine the degree of intensity of reaction between host and donor.

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EARL C. PADGETT

MASTER SURGEONS OF AMERICA

JOSEPH PRICE

ON a plantation in Rockingham County Valley of Virginia, Joseph Price was born January 1 1853 the site of his birthplace being but a few miles from that of McDowell. He received his early schooling at Fort Edward New York, and was later graduated from Union College, New York. He read medicine with his brother Mordecai and was graduated from the Medical Department, University of Pennsylvania, in 1877. He married Miss Louise Troth of Philadelphia and to them were born seven children—three boys and four girls.

Probably the first major operation ever performed by Price was for criminal abortion and he was often heard to say that an operation of this character would be the cause of his death. Strange as it may seem he was at least partly correct, for in 1909 while operating upon a patient, the victim of a criminal abortion, a wound in his finger became infected and he never entirely recovered from the infection. He lived for two years, however and his remarkable vitality and persistence are shown by the fact that he performed an appendiceal operation the day he died June 6 1911.

Dr. Price was about five feet ten inches tall, and weighed one hundred and eighty five pounds. He had keen piercing, gray eyes which looked out from beneath shaggy eyebrows. He was endowed with unusual vitality inexhaustible energy and was as vigorous in mind as in body. He was a boxer of more than ordinary ability an excellent rifle and pistol shot, having won the rifle championship at the Philadelphia Centennial. He was a big game hunter very fond of horses and dogs, in fact of all outdoor life. His home was a museum, his farm a menagerie. He would not soil his hands by rectal or vaginal examinations and in 1908 was heard to say that he had given up his dogs in order to keep clean and should give up his horses of which he had a great number.

His moods are rather hard to describe. He never seemed in the least excited or worried while actually operating nor was there ever any hesitation. However it was very common for him to enter the operating room very considerably irritated 'up in the air' we called it. On these occasions he was likely to unload on someone. Once when he had been unusually severe on his brother Mordecai Dr. Will Mayo said to Mordecai, "Why do you stand it? Gave it back to him,



JOSEPH PRICE
1853-1911

to which Mordecai replied, "It does not hurt me and does Joe a lot of good " On one occasion the source of his anger was the offer of a Philadelphia politician to secure for the Price Hospital certain state funds Price no doubt rightly guessed that there would be strings attached and exclaimed, "No, I am the boss here, from the coal heaver to Kennedy I can fire any of them "

He was dogmatic, whimsical, eccentric, original, forceful, courageous, and usually devoid of diplomacy, *usually* because we must remember that he founded and successfully operated a private hospital, and no man can do that without using some diplomacy Probably no physician had more friends or more enemies in the profession

He hated the polished meaningless sentences issuing from the suave gentlemen Sinclair Lewis has styled "men of measured merriment " He was a crusader and looked to the young men to "carry on " He was constantly urging these young men to re-educate themselves, then to go home and do at least emergency surgery, even though the circumstances were very adverse "Operate in the cotton gins, at the cross roads, in the kitchen, any place to save a life " "Don't let the woman die if you have to tie the pedicle with your shoestring " "I wouldn't give a cent for a young man who hasn't sat up all night and gotten covered with vermin while preparing for an operation the next morning You must operate upon the poor before you can operate upon the rich " We must remember at the time Price was giving us this advice hospitals were very few and far between, and many people were dying for want of early surgery

His personality was so powerful and outstanding that he had the absolute confidence and esteem of his patients, to them he was gentleness personified, if the sheets were not just right he would straighten them out himself, then with a smile say, "take a deep breath clear down to the end of your toes and go to sleep "

His professional life may be said to have begun in the Philadelphia Dispensary, in 1877 Here he organized the gynecological and obstetrical departments of this, the oldest free dispensary in America The actual obstetrical work was done in the homes of the slum cases by senior students who were required to have a cake of soap, a new scrub brush, and material with which to tie the cord The student was permitted to make only one examination As the gynecological operations originating in the dispensary were performed in the homes of the patients, it was necessary to develop a simple technique if success was to attend his efforts Every material used was boiled instruments, towels, gauze, and sutures He cleaned up a small circle and stayed within that circle An ironing board was used for an operating table, on a kitchen table covered with boiled towels he placed his small copper sterilizer containing a very few instruments "Here under the most unfavorable surroundings at the very dawn of aseptic surgery when it had received no very substantial endorsement by the

leaders of the profession a master mind dominated the most unsurgical conditions and conquered opposition." In such surroundings he is said to have performed one hundred abdominal operations with but one death.

For eight years he had charge of the Preston Retreat. During this time he wrote and spoke much on clean obstetrics, for which he waged an almost constant battle. It was largely during this period that his dogmatic expressions, harshly spoken words, and lack of diplomacy made him many enemies.

To a man of Price's disposition a private hospital was a necessity and so we found him establishing his hospital which was four stories high and had an operating room on each floor "four dollar operating rooms" he termed them. Other than a very small copper sterilizer eight by sixteen there was practically nothing in the operating room that could not be found in any home. The operating table consisted of a broad board which lay on a couple of saw horses and under the table was a zinc wash tub. If the operation was a vaginal one Price sat on a split bottom chair similar chairs being provided for the spectators. The legs of the patient were held by two assistants. Of course this was all intended for teaching purposes. Simplicity was a keynote of all he did he abominated "fuss, feathers and foolishness.

After the erection of his hospital the patients from the dispensary were cared for there, no charge whatever being made. The amount of charity work done by Dr. Price was enormous. It is one thing to do a charity operation, quite another to bear the hospital expense also. Here Price developed into a great teacher, and to his clinic came men from all parts of the world.

To describe his manner of operating is impossible the word "ease" comes nearest it. He never seemed to hesitate never to make the wrong move, but always to make the right move to accomplish the object intended, and he never showed a trace of indecision. He used very few instruments and these were small. His regular layout consisted of one knife, one pair of straight scissors, six hemostats, if a breast operation twelve two small clamps, and some straight needles. He used no retractors, no needle holders, no curved needles he did not use the Trendelenburg or Fowler positions. He used exceedingly few ligatures. On one occasion accompanied by a friend he visited a celebrated clinic the last operation was a breast amputation during which very many ligatures were used. Upon leaving, for a time he was very silent, then looking up he said "If that woman dies it will be because she was bitten to death yes, Stuart, bitten to death." Question had he already unconsciously worked out the theory of nocu-association? He seemed to operate very largely by sense of touch, to have an almost uncanny knowledge of the lines of cleavage thus in pelvic infections having once introduced his hand he did not remove it until the affected part was enucleated. His work was almost unvarying in its sameness, the patients were always carried in and out of the operating room by two doctors and one

nurse, they were handled always identically the same way, the blankets were always pinned around the patient in exactly the same way

Dr Price was one of the first to advise an immediate operation in ectopic pregnancy In one case he made the diagnosis over the telephone and commanded that the woman be left lying on the floor until he could get there Upon arriving he made his preparations, then lifted her on the ironing board and successfully operated He was one of the earliest advocates of immediate operation in appendicitis This operation he did beautifully with two straight needles and pair of scissors, the entire appendix being cut out of the cæcum He likened the retrocæcal appendix to the tail of a dog tucked between its hind legs

Price, was first, last, and all the time a gynecological abdominal surgeon but he was not uninterested in other branches of medicine We find him discussing sanitation, prevention of typhoid, preservation of milk, and he even wrote an article on the "Conservative Management of Undescended Testicle" He was greatly distressed over the increase of the number of feeble-minded, and believed that they should not be allowed to procreate

He hated shams of all kinds and was fond of exposing them A certain physician had been claiming to cure abdominal tumors by electricity and was to read a paper before the county society narrating these cures At the conclusion of the paper Dr Price exhibited a large number of tumors which he had removed after they had been treated by the essayist Of course, many erroneous opinions of Price's surgery exist Recently a well known surgeon who knew Price in his early days stated that Price did not believe in the germ theory This hardly seems correct when we consider the terrific scrubbing he gave his hands, face, and head and the large amount of bichloride he used

We may safely assume that the same brain that placed him in the forefront in his youth kept him abreast of any real progress in his old age

A man must stand or fall by the judgment of his peers Dr William Mayo said, "Dr Price was the father of abdominal surgery in America He was a man of fine scientific imagination and most skillful as a surgeon His greatest work was as an educator" Dr Robert T Morris "His convictions were as strong as those of Martin Luther or John Brown and all his powers were aimed at the fixation of his own ideas upon others" Dr Howard A Kelly "Dr Price was a pioneer in the newer aggressive surgery and a great leader and teacher, he did more than any man I know to fashion the methods we pursue today He was brilliant as an operator achieving the greatest results by the simplest methods" Dr W W Babcock "With the passing of Price, America lost the foremost of its early masters of abdominal surgery"

The writer left Price's clinic one morning in company with a very distinguished surgeon and author For a time my companion was in deep thought Finally he looked up and exclaimed, "A Master Surgeon"

A. P. BUTT

EARLY AMERICAN MEDICAL SCHOOLS

THE INDIANA CENTRAL MEDICAL COLLEGE

WILLIAM N. WISHARD, JR., M.D. INDIANAPOLIS, INDIANA

THIRTY TWO years after Indiana had attained her statehood, the trustees of the 15 year old Asbury University (now DePauw) nominated Indianapolis, the then frontier State Capital of some six thousand, as the future site of a medical school to be under their patronage. The parent institution, projected by the Indiana Conference of the Methodist Church in 1835, was incorporated under an Act of the State Legislature in 1837, published the first catalogue in 1839, graduated her first class in 1840, and blossomed from a faculty of 3 and student body of 85 at its inception to a thriving university of nearly three hundred at the end of her first decade. Large contributions having come from Greencastle, the University was founded there, a location, as the first catalogue mentions "as healthy as any part in the West, and while sufficiently easy of access, it presents few of those temptations to vice which are so abundantly found in larger places, or upon the leading thoroughfares."

In 1848 a committee of the Board of Trustees, comprised of E. R. Ames, J. L. Smith, and John Wilkins, formulated details for a Medical Department with five professorships to have full power to govern, maintain, and regulate the school, neither the trustees nor the college resources being in any way financially responsible for it (1).

"The friends of this enterprise in Indianapolis have come forward with their usual liberality and magnificence, and offer to fit up, at once, a large and commodious building, having ample space for lectures, dissecting, library apparatus, and museum. This places the institution upon an easy footing, and all the arrangements will be completed in the most satisfactory manner before the time shall arrive specified for commencing the course of instruction."

"The want of such an institution, then centrally located, is manifest to everyone who has reflected upon the subject; and the interest awakened in the public mind since the Board of Trustees has taken the subject under consideration gives the best assurance that the enterprise will meet the countenance and co-operation of all who desire to see an improved state of medical learning in Indiana. As an announcement will be issued in July next. In the meantime we would say that it is the intention of all concerned

to make the Indiana Central Medical College equal to the best in the country" (2).

The faculty (3) selected was as follows: L. Duniap, professor of surgery and surgical anatomy; J. S. Bobbs, M.D., professor of general and special anatomy; R. Curran, M.D., professor of physiology and pathology; J. S. Harrison, M.D., professor of materia medica, therapeutics, and medical jurisprudence; G. W. Mears, M.D., professor of obstetrics and diseases of women and children; Chas. G. Downing, A.M., professor of chemistry and pharmacy; Tarvin W. Cogwell, M.D., professor of theory and practice of medicine.

That the new school was heralded by no fanfare of trumpets is attested by the paucity of news about it in the public press of that day. One paper (4) located the new medical college on the third floor of the Johnson Building, large enough to handle one hundred and fifty students, went on to say that the central location would make it a medical graduating point for the State; would double the transient population, increase business, and closed by advising the Legislature to move the State University to the same city.

Whatever the Indiana Central Medical College may have lacked in physical endowment was compensated for by the 7 able faculty members, at least 5 of whom still live by reputation in the community. Dr Duniap was the first president of the State Medical Society. Dr Mears provided a permanent income to purchase medical literature for the Indianapolis Public Library. Towering over all was Dr J. S. Bobbs, the dean of the faculty. Instrumental in the organization of the State Medical Society and prominent during its first 30 years both politically and scientifically interested in civic affairs of the community, advocate of local educational institutions, first surgeon in the world to perform a cholecystectomy and donor of Indiana's earliest free dispensary, it is perhaps not unfair to his contemporaries to nominate him as leading physician of the state for the middle third of the nineteenth century. Having

come to Indianapolis some years before 1849 as a graduate of Jefferson Medical College, his already influential position, as well as professional, educational, and administrative talent, was doubtless paramount in causing the decision of the Asbury trustees to venture a medical department

Dr Bobbs' attitude toward the local school may be read in his own words (5) years after its demise As president of the Indiana State Medical Association in 1868 he was replying to an address of a former president, Dr Kersey, who had asked

"What do we want with a medical school in Indiana? Surely nothing, unless it be established on a scale and basis to compete in excellence, in eminence, in every appliance and means of instruction with the best schools of the age. It should assume a high rank among our positive luxuries for it could not be regarded in the light of a necessary institution. It should be richly endowed conferring degrees on merit only. Such an institution will be welcome whenever it comes"

Replied Dr Bobbs

"We have no doubt of it—such luxuries are like angels' visits, and cannot fail of appreciative recognition whenever they appear without disguise.

"But it suggests the consideration. When this professional millennium may be reasonably looked for? Whose cry in the wilderness will herald its advent?"

"That a Medical College will ever be established in this State on an independent basis, and with the wealth of appliance required by this standard is possible—how long it will precede the general resurrection is problematical. That man is given to the indulgence of a lively faith who cherishes the hope of its early realization.

"I cannot resist the conviction that a good medical school in Indiana would tend to the cultivation of medical science. Its influence would be more widely felt if it aspired to a less exalted position at inauguration. There is a fitness of things which cannot be safely disregarded in the practical affairs of life. It seems to me it requires, in this case, that while we demand a higher standard of qualification in the student, we should couple it with the means of obtaining that platform, and that it will better subserve the interests of the profession and the people to elevate the great body of the former to a creditable position than to attempt to confer eminence on a few and nothing on others."

The medical college opened with 49 students on Monday, November 5, 1849, being located on the southeast corner of Washington and East Streets. Aside from the models, drawings, instruments, anatomical specimens, and other apparatus which it afforded, an opportunity was offered for clinical observations with the professors in their private practice. Courses were given in anatomy, physiology, therapeutics, medical jurisprudence, obstetrics, gynecology, pediatrics, chemistry, pharmacy, surgery, and medicine. The State Constitutional Convention and Legislature of 1850 were advanced by the catalogue as added



John Stough Bobbs, 1809-1870, Dean and Professor of Surgery, Indiana Central Medical College 1849-1852. Performed first cholecystostomy in the world.

inducements for acquaintances which might lead to information about desirable openings. For a degree the student must be 21 years of age, have studied medicine 3 years, completed two courses of lectures (one at least in this school), present a thesis to the Dean, and pass the final examination. The fee was 70 dollars for the full course. Board, room, fuel, and lights could be had for 2 dollars a week (6).

In his address (9) at the opening of the school, Dean Bobbs justified its organization on the ground that the State, with a million population, had too many quacks and too few graduate physicians, and that increased educational facilities would improve the status of the doctor. Discussing some of the quasi-reforms of the day urged upon the public he said

"The chief advance in science of medicine is improved diagnosis. The chief characteristic distinguishing Empiricism from science in medicine is its contempt for diagnosis and reliance on *materia medica* to advance the healing art. Empiricism is labor saving and time sparing, economizes brains, and hangs the issue on the horns of chance. Thus you fish for health like a boy for eels, and when you have luck you may catch it, but it is a wet and slippery venture. Thompsonianism dispenses with any knowledge of anatomy, physical pathology, chemistry, or surgery and is a liberal indulgence of the public towards gents of small wits, who, having a repugnance to labor, mental and physical, are allowed to dispense with both in the preserving of life and health. Homeopathy was invented for the benefit of common people—those who are prone to confound change with improvement. It rests on a skillful reduction of integers to decimal fractions in potions administered. It is a considerate suspension of the laws of

nature in tenderness to kid and setta, whose debility stomachs reveal at numerous doses, and afford a convenient way of physicking children of all ages and old women of either sex. Eclecticism counts liberally from outside medicals and makes the practice of medicine simple and divested of responsibilities. Where ignorance is bliss it were folly to be wiser and when one is resolved to wear a bandage over his eyes, blindness is as good as perfect sight.

"Empiricism, Thompsonianism, Homoeopathy and Eclecticism are fashionable fashions of the day which, with others to come, must be met. There have always been those with audacious pretensions of ignorance who discover a more speedy and certain remedy than the usually adopted one. Medical science has turned in her bosom the noblest specimens of humanity that have adorned the annals of man. Men of talent, education, and devotion to interest of their fellow men have found in the profession motives for their arduous and unrelenting labor in its destiny to transcend the condition of the afflicted. These are those who have colored our knowledge and given firmness and certainty to its maxims. To these we owe all that is valuable and enduring. The men who have analyzed each bond, and patiently dissected each fiber; elaborately explored every organ, and scrutinized every function; and who deduced the living truths that have given enthusiasm and perpetuity to the science after long years of arduous labor. They sank into their graves, not into oblivion, but, planted deep in the firmament of the past, their names will shine out in the future, bright as the star that lights the dawn brow of night. Among them, select your exemplar. Put in repetition the best attested maxims in the hands of the profession for the salvation of the patient.

The first commencement (7) was held in Wesley Chapel on Thursday February 28, 1850, a large crowd attending. Ten degrees of M.D. were conferred by Rev Lucien W. Berry D.D., the President of Ashbury University. Professor Harrison delivered the valedictory address, speaking on "Professional Indignity." The "Indiana State Sentinel" (8) a weeks later commented "that the professors were residents of a new country yet would adorn any land, being practical men with sound heads and stores of medical information, drawing attention also to the need of more doctors of medicine, and the obvious advantage of a school in Indianapolis. Opposition had evidently been met on sectarian grounds, the 'Sentinel' remarking that several of the faculty belonged to no church, that previous to the new school a birth the door was open to all, 'but none others were equal to the task of originating and sustaining such a school' (8).

When the fall term for 1850 began there were 41 students, all residents of Indiana. Dr. Daniel Meeker was appointed professor of general and special anatomy. Professor Baker's name was no longer listed in the catalogue. Dr. Bobbs had assumed the chair of surgery and Dr. Denting that of special pathology and institutes of medicine. The preceptor of each student was listed, many of whom held no degree at all. During the term one D. J. Lee became the subject of some

ridicule by his fellows because his preceptor was not an allopath. Fortunately for the faculty it appeared that he had never paid his matriculation fee and was therefore dropped (10).

Professor Curran delivered the opening lecture of the second term (11).

"We are admirers of genius, but the man who can keep from the shop-board, or cotator, or agricultural pursuit, or any other honest and respectable calling, and in a few short weeks penetrate the mysteries of the medical art; embracing a knowledge of anatomy, physiology, pathology, surgery, materia medica, chemistry, mental medicine, manipulation. Is a prodigy that confounds, overwhelms and astounds us. Yet there are such prodigies everywhere if we resolve their tinkering—men, and women too, who seem to comprehend the wonders of the healing art by intuition, and that which renders the prodigy more prodigious is that a great multitude are foolish enough to credit such pretensions, and upon this ill bestowed and misplaced faith, live and thrive practitioners who have the audacity to claim the title of physicians without ever having studied for one moment seriously upon the elements of the science. There is no royal road to medical learning.

During this second term a number of clinical case reports were published in the public press (12) "Bronchitis," "Operation for Clubfoot," "Operation for Artificial Iris," and "Inflammation of the Lachrymal Duct," were some of the titles. Interesting also were the theses prepared for degrees, including such topics as "Pneumal Fever," "Chloroform," "Acute Rheumatism," "Normal and Abnormal Actions," "Hysteria," "Temperaments," "Via Mediatricis Naturae," etc.

An attempt was made in 1850 to erect a building for the school on the University Square, the Legislature authorizing the sale of an acre at an appraised price, but the appraisement was thought too high (\$3,500.00) for the University's means and the enterprise was abandoned (13).

February 24, 1851, the second commencement (14) was held, this time in Roberts Chapel. Twenty-one M.D.'s (three of which were honorary) were conferred by Rev. Berry. In the catalogue of 1850 (15) announcing the 1851-52 session we read:

"The Trustees having adopted sufficient measures to provide for the erection of a suitable college building, the foundation is placed upon a permanent footing, and the consolidation of the Indiana Medical College, situated at La Porte, Indiana, and the Indiana Central Medical College, has transferred two excellent teachers in the former faculty to the latter and contributed many valuable additions to the means of instruction that had been previously liberally provided.

When the third and final term began in November 1851 41 students in attendance, only 2 names on the original faculty of 1849 appeared (16) R. S. Patterson, professor of general and special

anatomy and physiology, C W G Comegys, professor of materia medica, therapeutics and medical jurisprudence, C G Downey, A M, professor of chemistry and pharmacy, S E Leonard, professor of obstetrics and diseases of women and children, J S Bobbs, professor of principles and practice of surgery, E Deming, professor of pathology and theory and practice of medicine.

The last commencement (17) was held in Wesley Chapel February 25, 1852. Sixteen degrees (including four honorary) were given by Rev Berry. An attempt was then made to reorganize the school. The catalogue announced that "the Trustees of the University at their late meeting, permanently located the Indiana Central Medical College at Indianapolis, reorganized the Faculty and adopted efficient measures to furnish a suitable college building and other means of instruction. The institution may now be regarded as upon permanent footing" (17). How permanent was this footing? No further Asbury catalogue refers to a medical department. Frequent vacancies in the faculty had occurred, the trustees having been unable to care for it in any efficient way. The school was suspended in 1852 until sufficient funds could be raised to maintain it, and a committee appointed to take charge of the medical apparatus (18). From that time until the fall of 1869 no semblance of a medical school existed in Indiana.

To this institution go the very real distinctions of being the first medical college in the city, the first medical department of a Methodist school in the United States, and the third medical college in the State.

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THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE clinical experience of Bumpus and his associates in the management of common urological conditions is concisely presented in a new volume. The introductory chapter on anesthesia, the preparation of the patient, and the sterilization of instruments contains many helpful hints in proper urological technique.

Strictures of the urethra, bladder and ureteral calculi, and urethral caruncles are neatly discussed from the treatment standpoint only. Many important points in technique are illustrated by excellent drawings and photographs. The pitfalls in the management of some of these conditions are adequately stressed and pointed out.

The new treatment of prostatic hypertrophy by the transurethral route is given by Bumpus, who had had an unusual amount of interest in and experience with this procedure. He states that, in 1931, 42 per cent of their prostatic cases were treated by resection, and by the proper selection of cases an increasing number of prostates may be treated by this new method. The larger prostates, however, should be treated by prostatectomies. As a result of their observations these authors feel that if only the obstructing tissue is adequately removed, good, uniform functional results will follow. Resection of obstructive malignant prostatic tissue is frequently preferable to a permanent cystostomy tube. Contractions of the vesical neck and prostatic hairs are sharply differentiated from lateral lobe prostatic enlargement, and transurethral operations are advised with the modern vision punches and resectoscopes.

In the hands of an expert like Dr. Bumpus, a minor surgical procedure (resection) for the treatment of prostatic cases has so greatly simplified the operative technique that we may now include operative prostates which were formerly excluded by the open operation. However, inasmuch as prostatic enlargement is the affliction of the older man who usually has some associated cardiovascular renal disease, proper pre-operative and postoperative management still remains of major importance. Should this fact be ignored in view of a simple transurethral procedure, untoward results will surely follow, particularly in the hands of the inexperienced or novice who for

some reason or other may undertake to treat obstructive uropathy.

The treatment of *Bacillus coli* pyelonephritis with a ketogenic diet, as worked out by Barbock is outlined briefly with accompanying diet charts and weight tables. The management under this regimen has been found to give striking amelioration of clinical symptoms and improvement in the urinary findings.

This new urological volume is an asset to any medical library and an excellent reference for the specialist.

L. W. Riss.

A CONCISE and practical manual on cancer has been prepared by Mandl. His intention to present a brief compend which would cover the essentials of the theory and practice as well as the treatment of malignant disease has been fulfilled. Much of the material is drawn from the clinic of Hochenberg.

The first portion of the work is devoted to a general consideration of malignant disease. The various theories of the causation of cancer are discussed and the conclusion is reached that factors other than those advanced to date must obtain. In the discussion of the symptoms and diagnosis, the author stresses the importance of immediate radical operation after biopsy on the premise that the procedure stimulates activity in the malignant growth. After reviewing the various specific tests for malignant disease, the author states that the clinical history, general examination with biopsy and with the roentgen ray, the endoscope and the methods of special examination such as with biopsy and with the reliable means at hand today with which to make a correct diagnosis. Surgical exploration for deep seated carcinoma is often necessary for a short but extremely interesting description is given of the various forms of treatment. Surgical removal of the various forms of tumor and serum therapy the use of radiation therapy toxin and dyes are discussed in a general way. Mandl is of the opinion that in specific instances, radiation therapy is the treatment of choice, but that in general the surgical removal with the judicious use of radiation, either radium or the roentgen ray, offers the best and only reliable form of therapeutic approach.

The second portion of the book is devoted to malignant disease of special parts or organs. The

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MAJOR CLINICAL MANAGEMENT, MEDICAL SURGERY OF THE UROLOGY
By Bumpus, C. Bumpus, Jr., Ph.D., M.D., M.B., F.A.C.S.
1931. Chapter on Cancer by John L. Combs, M.D., F.A.C.S., Chap-
ter on Postoperative Care by James L. Clark, M.D., F.A.C.S.
and London. W. B. Saunders Company 1931.

author presents a brief but lucid description of the disease as it affects the various organs, including the forms of growth, the symptoms, differential diagnosis, and the treatment which in his experience has yielded the best results. At the close of the description for each region, statistics from other large clinics are quoted.

For a small compend of 144 pages, this little work incorporates an enormous amount of valuable information which is shorn of all verbosity. For the student of medicine, the general practitioner, even the student of malignant disease, this work is invaluable since in such a concise form there is available so much useful information. The conclusions are well drawn and the author clings to the accepted form and is not beguiled by phantasy or will-o'-the-wisps.

J. A. WOLFER

THE book by Straub on *Surgery of the Chest*¹ presents, in 474 pages, a brief survey of the field of thoracic surgery. The sections on normal and pathological thoracic physiology and on the general principles and technique of thoracic operations are succinct and excellent. They are obviously based upon a wide personal experience and a thorough familiarity with the literature. The many illustrations, most of them sketches and diagrams by the author, evince a skill in this field not short of professional. They compare favorably with those done by Graves for his textbook on *Gynecology*, not only in their execution but in the aptness with which they supplement the text. As a brief text on the operative surgery of the thorax, the book is decidedly valuable.

In any branch of surgery, which is undergoing rapid evolution, experiment is rife and obsolescence rapid. This is true of thoracic surgery at the present time. While in the past 50 years many principles and procedures have become finally established there are many others the value of which is uncertain. To expect an author to do what time alone can do, to judge and choose between these, is to expect the impossible. In most instances, the therapy recommended is safe and tried, and the selection and evaluation of procedures is carefully done.

I have said that this is an excellent brief text on the operative surgery of the thorax. The chief problems of thoracic surgery are not operative. They concern themselves with diagnosis and with indications. The sections of the book which deal with these phases are too brief and present dogmatically too many disputed questions to be satisfactory.

Criticisms of the book might be many but these would be partly matters of variations of opinions and wholly criticisms of the present status of thoracic surgery. Personally, I cannot agree with the author that phrenico-exeresis has little value save as an accessory procedure, nor do I feel that experience with cautery lobectomy has justified its further use. Thoracoplasty is recommended for bronchiectasis

yet the results from this procedure in this disease are scarcely commensurate with the risks and the deformity. I could continue mentioning differences of opinion. In general, I feel that a very unsettled and uncertain field has been dealt with too briefly to give a just conception of the problems daily encountered as to indications.

J. H.

HUDDELESON has given us a most valuable and timely book.² Its thoughtful study by all who have to do with compensable injuries should work mightily in the prophylaxis of traumatic neuroses. The happiness and usefulness of thousands of patients and the expenditure of many millions of dollars are closely concerned with enlightenment of the physician who first attends the injured and with the manner in which compensation is awarded. As Huddleson says (page 180), "In any community, the sooner the economic and psychologic influence of compensation is terminated, the better for all concerned. Most effective is the promptest possible lump sum award, or denial of award by an authority from which there is no appeal. So long as a traumatic neurotic has a law suit pending so long as he continues to be a claimant for compensation, he is practically incurable."

The book is very readable. It contains abundant valuable references to the literature and numerous interesting case reports. The reviewer most emphatically endorses its importance not only to all medical men concerned with industrial work but also to compensation boards and legislators.

FREDERICK CHRISTOPHER

SEEMEN³ has presented an exceedingly valuable contribution to the subject of electrosurgery in his new book. In the judgment of the reviewer it presents the most complete bibliography and review of the literature on the subject of electrosurgery thus far prepared by any author. From the historical standpoint, Seemen has developed a logical sequence from the century-old use of the hot iron, through the period of the cautery to the present day of electrocoagulation.

In talking or writing on electrosurgery various authors employ such terms as surgical diathermy, endothermy, radio knife, etc. Under electrosurgery this author has adopted the terms, electrodestruction, electrocoagulation and electromy. He recommends the latter term as designating the electrical cutting current. Even this comprehensive book on this subject shows the need for developing an international nomenclature applicable to all forms of electrosurgery. Seemen gives a very complete description of the various electrical currents used in electrosurgery and makes valuable sug-

¹ACCIDENTS, NEUROSES AND COMPENSATION. By James H. Huddleson M.D. With a Foreword by J. Ramsey Hunt, M.D., Sc.D. Baltimore The Williams & Wilkins Company 1932

²ALLGEMEINE UND SPEZIELLE ELEKTROCHIRURGIE. By Dr. med. Hans v. Seemen. With a chapter on Elektrochirurgie der Geschwülste in Verbindung mit Strahlenbehandlung by Dr. med. Otto Schürch. Berlin Julius Springer 1932

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gestions as to the various instruments to be used in connection with it. The different machines developing the currents which he describes are chiefly of the German make.

The chapter on histology contains beautiful illustrations and complete descriptions of those studies which have been made following the use of the electric current. These studies refute the claim of many of our pathologists to the effect that the electric surgical currents so destroy the tissue removed at biopsy that histological study is impossible.

In the section on "Special Electrosurgery" the author opens up a wide vista of usefulness for electro-surgery. As practiced by most surgeons in this country electrosurgery has been restricted largely to malignancies. Dr. von Seemen has used it in amputations, in infections, especially carbuncles, osteomyelitis, in gastro-intestinal surgery of non-malignant nature, and in several other conditions. This author's description and illustrations of large numbers of cases of carcinoma and sarcoma, of the

lips, oral cavity the eye, ear and other parts of the head, furnishes extremely convincing proof that electrosurgery offers real hope in many cases of heretofore called inoperable malignancy. The plastic operations described throughout the book to overcome severe deformities, especially about the face, remaining after the removal of a malignant growth by electrosurgery makes this publication a fairly valuable one from the standpoint of the man doing plastic surgery.

Dr. Schnerch, Zurich, has a chapter in this volume which details several very advanced cases of carcinoma and sarcoma, of the face, oral cavity, and of the rectum, wherein he uses a combination of electrosurgery and radium.

A criticism of the book might be offered in that more emphasis might have been given to the use of electrosurgery in removing carcinomas of the breast, in performing a thyroidectomy, and in doing brain surgery. On the whole, the volume is a real contribution to the field of electrosurgery.

HARRY E. MOCK.

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